ENCHIRIDION

OF FORTIFICATION,

OR

A handfull of knowledge in *Martiall affaires.*

DEMONSTRATING

Both by Rule, and Figure, (as well Mathematically by exact Calculations, as Practically) to fortify any Body, either *Regular*, or *Irregular.*

How to runne *Approaches*, to pierce through a *Counterscarfe*, to make a Gallerie over a *Mote*, to spring a *Myne*, &c.

With many other notable matters belonging to Warre, usefull, and necessary for all Officers to enrich their knowledge and practise.

Never before Imprinted.

Audaces Fortuna juvat.—

LONDON,
Printed by *M. F.* for *Richard Royston*, and are to be sold at his shop at the signe of the *Angel* in *Ivie-Lane.*

XUM

The Author, to his Book.

GOe little Book, thine aid afford
Vnto the Battailes of the Lord.
Thy Commiſsion (underſtood)
Is onely to aſsiſt the Good.
If the Bad doe chance to draw
Thee to help them, 'gainſt the law:
(As they may doe, 'tis no doubt;
For what's a Handfull, *'gainſt a rout?)*
Excuſe it, with this harmleſſe jeſt;
'Tis the firſt time, you were preſt.

Dedicatorie.

YOu for whom this work was fram'd
(In the Title Good, *you are nam'd;*
Adding thereto, if it may bee
The quinteſſence of Chivalree *)*
Bear it to th' Field, *and let it bee*
At Rendevous's *your Company.*
Where, for your leſſon, and your ſport,
You every day may take a Fort.

Vale.

To the Author of the *Enchiridion* of *Fortification.*

AS through a *Proſpect-glaſſe revers'd, we ſee*
The world reduc'd to ſmaller quantitie;
And yet each object in its Species *hold*
A due proportion to the great; I'm bold,
To ſay thy Handfull *doth as much compriſe,*
As all the Volumes *you* Epitomiſe.
And one thing 'bove the reſt to crown thee's this,
(Which both my friendſhip, and my knowledge is)
Others to ſtrengthen Polygons I find;
Thou fortify'ſt the Body, *and the Mind.*

R. M.

To his worthy friend, the Authour.

I fain would fortifie thy praiſe
'Gainſt envy, but can find no wayes,
But what thy book doth ſhow:

Thine own *lines* runne to thy *defence*,
That neither th'Art, nor lines, nor ſence
Can be diſlik'd I know.

'Mongſt men of judgement, reaſon, wit,
And valour too (for whom 'twas writ)
By which I'd have it known,

Thoſe praiſes, which would ſeem to bee
Thy friends benevolence to thee,
Are not ſo; but thine own.

T.T.

To the Author, on his Book of *Fortification*.

COuld I erect huge Pyramids of ſtone
I would divulge thy praiſe, and name thereon:
But, ſince the cheaper way 'tis; I have took
What I indeed ſhould give thee, from thy Book;
Which is; I find in this thy glory ſhines;
Thy works though ſtrong, are taught by ſtronger (lines.

H. S.

A Proœme to FORTIFICATION.

AMbitious men, presuming on the authority which the *Creator* gave them over all the Creatures, and Beasts of the earth; sought to ground their *Tyranny* on that principle, and comprehend all *Men* under their subjection; as being irrationall in respect of themselves. But *God* who made man, (and consequently al men to one end, which is) to serve him, and to shew his *Omnipotence* in *Creating* so perfect a *Figure*, as his own *Image* in *Man*: to set a distance betwixt him and those things wch were only formed for his *use*; hath raised him up from the ground, that with an erect and sublime countenance, the secret rayes, or lines of his looks might be conveyed to their most proper *Center*, and Maker. Adding thereunto a reasonable Soul, to distinguish betwixt good and its contrary: One of the rest of whose faculties is, to know a friend from a foe; giving him also a *Spirit*, both to foresee, and pre-

prevent; and a *Courage*, boldly to repell any mischiefe which is ensuing towards him from his enemies.

Habet & musca splenem.

And the pooreſt worm being trod on will turn again: How much more then muſt injuries, and affronts offered to men, expect to be repayed in their own coyn! Hence it came (back'd with a deſire to diſtinguiſh betwixt *meum & tuum*) that people congregated, and placed their habitations in as neer a Circuit as might ſtand with conveniency: that being joyntly united in a firme combination, they might the better withſtand, and repulſe any invaſion, or uſurpation of enemies. Nor did they repoſe their whole confidence in the dint of the ſword alone, & ſo conſequently be made lyable to engage man for man: but fearing an over-maſtering number, ſought rather by al means to fortifie, and make ſtrong al ſuch their Situations, by *Stratagemicall-Circummunitions*. The which at the firſt (as at this preſent amongſt the Indians) were nothing elſe but Piles driven into the ground in manner of an *Impalement*. But *Experience* (the *Correctrix* of all *Capriccio's*) taught them that their impalements of wood were not able to reſiſt fire, and divers other inconveniencies which might accidentally befall them: Wherefore neceſſity brought them

them to know, that wals made of *Stone*, *Brick*, or *Earth*, muſt needs excel this their way of fortifying. Then were they long in uſe; until ſuch time, as their imperfections alſo by ſad experiences were made known: And, that by the force of Engines they were divers wayes attempted, yea many times overthrown, and demoliſhed; which cauſed them from time to time, to ſeek remedies for thoſe defects. For firſt of all, perceiving that their wals without additionall props, and defences, were ſubject to be beaten down with Rams, and other ſuch like ancient warlike Engines, now, long time ſince out of uſe; they placed in the front of their wals, divers *Spurs* and Roundles, to hinder the beating of them down: And on the inward ſide, they gave them a *Talud* or ſlooping, which increaſed them in thickneſſe towards the bottome, in manner of the ſide of a *Pyramis*; thereby enabling them the better to reſiſt the violence of thoſe Engines. Then ſecondly, theſe wals were made in divers formes, and firſt in a Round: which though it was held to be the ſtrongeſt, (becauſe the force of the Engine did rather ſeeme to ſettle the ſtones cloſer, (in regard the Exteriour *Circle* was greater then the Interiour) then any way looſen, or break them, but by great labour, and with much difficulty) yet on the contrary, Approaches being made up unto them, it was impoſſible

possible to discover and flanke all parts thereof; which gave great advantage to the enemy, to scale, or myne uninterrupted. So that afterwards they were reduced into a *Square* forme, with *Redouts* on the *Angles*, which might flank and defend the *Curtains*, making them also *demi-circles*, with angles exteriour and interiour. And lastly, those *square Redouts* on the *Angles* of the *Polygon's*, were altered to a triangular forme (used at this day under the *Terme* of Bulwarkes) on the one side, that their bulke might the better resist the furious force of the Cannon: and on the other side, that they might be the more capable to defend themselves, by discovering every part of the wall, even to the very foundation, or *superficies* of the water, if it be invironed therewith: The which in all Fortifications is very behoovefull; for how can those men be interrupted to myne, or scale a work, who are not seen? And as the invention and practice is grown to the highest degree in these our days, both for attempting and defending, by reason of the long experience of the wars in many neighbouring parts; so especially in the Low-countries, the manner of whose *Fortifications* is conceived, (and generally approved of) to be the exactest, strongest, and perfectest works that can be invented. Therefore have I chosen, and pickt out the most select, and choice flowers (of those

thoſe many which have been gathered out of that great nurſery of *Martiall diſcipline*, by *Samuel Maralois*, & others of great skill therein, and profound *Mathematicians*, directed to the moſt neceſſary by mine own experience) as it were into one handful, to delight & adorn the nobler ſpirits of theſe our times. By whoſe induſtry they (being tranſplanted) may flouriſh in this Country, and defend them here with the ſame immunity, as where they firſt did ſpring: wherefore that I may lead you on *gradatim* to the knowledge of *fortification*, I hold it moſt convenient in the firſt place to explaine unto you the names, & proper *Terms* of the ſeverall *Lines*, and *Angles* therein compriſed. The which I have here following moſt plainly demonſtrated by the letters of the *Alphabet*, as well on the *Ichnographie*, or *ground-plot*, in the 3. *Plate*, which is the firſt expoſitor thereof; as alſo by the *Figure* marked *Profile* 2. in the 4. *Plate*, which are as followeth.

Ichnographie, 1. or *ground-plot* on the third *Plate*.

A. the Polygon.
N. O. the ſide of the Pol.
N. D. the line of the Gorge.
D. C. the line of the Flanke.
B. N. the Capitall line. *B. C.*

B. C. Q. R. the moate.
P. the Raveline, or ½ moone.
Q. the Covert-way.
T. S. the Parapet thereof.
B. I. the line of defence.
D. K. the Curtaine.
K. F. the Parapet.
K. M. the Rampart.
A. N. the Semi-diameter.
V. C. the Flanke lengthened.
C. D. N. the Angle forming the flanke.
B. C. D. the Angle of the ſhoulder.

Orthographie, or *Profile*. 2ly: in the 4. *Plate*, thus.

A. B. the foot, or Baſis of the Rampart.
G. H. the height of the Rampart.
H. B. the Talud, or ſloope of the infile of the Rampart.
A. T. the Talud, or Scarfe, of the outſide of the Rampart.
D. the foot of the Parapet.
D. E. the Parapet it ſelf.
D. F. the foot banke.
F. G. the terra plaine, or breadth of the Rampart.
K. A. the way for the rounds, or the Falſe-bray.

M. N. the

M. N. the Scarfe.
N. O. the Moate.
O. P. the Counter-ſcarfe.
P. Q. the Covert-way.
R. Q. the foot banke thereof.
R. S. T. the Parapet of the Covert-way.

Some termes may happily be omitted in theſe figures which in their due and proper places ſhal be explained.

Note.

That the more *Angles* the *Polygon* or body required to be fortifyed conſiſts of, the ſtronger it will be, for the more obtuſe the angles of your Bulwarks are (which are called the *Angles* flanked) the better it is, and the Angles flanking are the more ſharp.

Now to encreaſe proportionably the *Angles* of the Bulwarkes, according as the *Angle* of the *Polygon* augmenteth; you muſt

Take the half of their *Angles* (viz. the *Polygon's*) and adde thereunto 15 degrees, the ſum will be the *Angle* of the Bulwark.

Then ſubſtract the angle of the Bulwarke, from the *Angle* of the *Polygon*, the remainder is

is the double of the angle flanking *Interiour*.

The which double being substracted from 180 degrees, there will remain the angle flanking *Exteriour*, called the *Tenaile*.

Adde to the angle flanking *Interiour*, 90 degrees, and that gives you the Angle of the shoulder.

To find out the Angle of any Polygon.

Let 2 be a common number to substract from the Angles of any *Polygon*.

Then multiply the remainder by 2, and that gives the number of *Right-Angles* contained in any *Polygon*. The which summe being multiplyed by 90, and divided by the number of the *Angles* of the *Polygon*, gives the degrees of each Angle contained in the Polygon.

As for Example.

5. angles of a *Pentagon*.
2.

Remains 3.
Product. 6.

90 degrees.
108. degrees. Being the extent of an *Angle* of a *Pentagon*.

This way of Calculating the Angles of a *Polygon* (set down by *Maralois*) I have more plainly exemplified

exemplified, both for the understanding, and memory, as followeth, *viz.*

5. *Angles* in a *Pentagon.*
2. deducted,
3. remains, which multiplyed by
2.
6. is the Product, which is the summe of the Right-angles contained in the 5 Angles of a *Pentagon*, and that being multiplyed by
90. produceth
540. which being divided by 5 (the number of the Angles of the Polygon) produceth
108. which is the degree of the Angle of a Pentagon.

By this rule the same effect is wrought in all the Bodies, even to a *Dodecagon*, or *Figure* of 12 Angles, or farther.

Because I know many Gentlemen (to whom I desire this work may be advantageous) are not very well skill'd in the *Mathematicks*, nor of great knowledge in *Geometry*: To make the knowledge of *Fortification* the more capable unto them, I thought it not amisse in the first place, to demonstrate unto them, how to describe the *Polygons* themselves, ere I proceeded to the Fortifying thereof; & that two manner of ways, as is exemplifyed by the figures in the first *Plate*, and first of all,

PLATE I.

In a Circle given to describe any laterall Polygon.

As 1. In a Circle given to describe an Equilaterall triangle.

Let *A. B. C.* be a Circle given, draw the Diameter *A. C.* and from the point *A.* to *G.* set the Semi-diameter, then draw the line *G. C.* and that shall be one side of an equilaterall *Triangle* subtending that Circle.

2ly A *Square.*

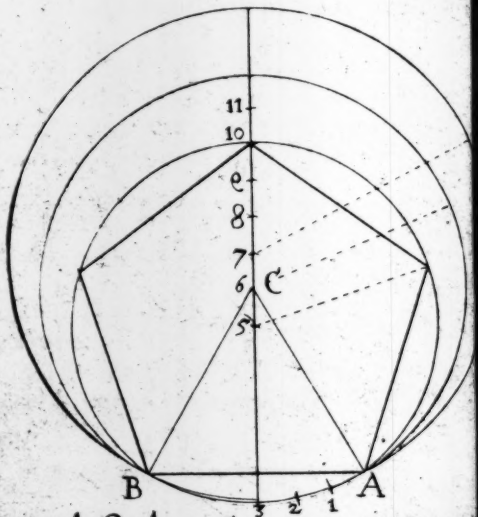
Draw two Diameters that shall cut each other at Right-angles in the Center *D*, and their extents shall divide that Circle into 4 parts, as the lines *A. B.* and *B. C.* demonstrate.

3ly A *Pentagon*, or *Figure* of 5 angles.

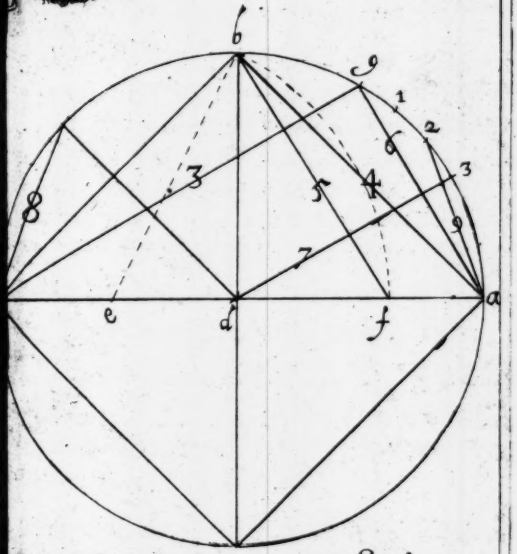
Divide the Semi-diameter into 2 parts at *E*, fixe there one point of your Compasse, extending the other to *B*, then mark that distance upon your diameter at *F*, and draw the line *F. B.* and that shall be a side of a *Pentagon*, subtending that Circle.

4ly A

Plate. J.



To describe a CIRCLE, to contayn any POL. whose sides must be answerable to a line given.



In a CIRCLE given, to describe any laterall POLYGON.

4ly A *Hexagon*

Is divided with the ſame diſtance of the Compaſſe wherewith the Circle was deſcribed, as the line *A.G.*

5ly A *Heptagon.*

Draw the ſide of a *Hexagon*, (being a Semi-diameter) from *A.* to *G.* and on the middle thereof erect a *Perpendicular*, (as the line 3 *d.*) and that from the Baſis *a. g.* to the Center *D.* ſhall contain a line equall to the ſide of a *Heptagon* ſubtending that Circle.

6ly An *Octogon.*

From the Center *D.* cut the line B. C. at right angles, then draw the line 8 *C.* and that ſhall be equall to the ſide of an *Octangular* figure compriſed in that Circle.

7ly An *Enneagon*, or figure conſiſting of 9 Angles.

Having cut the ſide of the *Hexagon*, *A. G.* into 2 equall parts, divide one half of that Section of the Circle which is cut off by the line *A. G.* into 3 parts. And give one part thereof to the other half of the Section, and draw the line 2 *A.*

which ſhall be a ſide of an *Enneagon* to be deſcribed in that Circle.

8ly: A *Decagon*, or *Figure* of 10 Angles, and ſides.

Divide the Semi-dimeter into 2 parts at *E*, (as was ſhewed for the *Pentagon*) and the line *F. D.* ſhall be the ſide of a *Decagon* to be contained in that Circle.

Secondly, To deſcribe a Circle to contain any *Polygon* whoſe ſides muſt be anſwerable to a line given.

Let *A. B.* be a line given, then with that diſtance deſcribe the equilaterall *Triangle A.B.C.* then in the Center *C.* draw the Circumference to which the Semi-diameter *C.* (being the middle prick'd line) extends making *A B.* (the line given) a ſide of a *Hexagon*, ſubtending that Circle.

Then divide that Section or part of the Circle which is cut off by the line *A. B.* into 6 equall parts, placing one part thereof on the *Perpendicular* below the Center *C.* which ſhall be the Center of a Circumference that ſhall contain a *Pentagon*, whoſe ſides ſhall be equall to *A. B.* the line given; as the lower prick'd line (from

(from the Center 5. being the Semi-diameter thereof) demonſtrates.

Place alſo one part above the Center *C.* and that ſhall prove to be a Center to a Circle which ſhall be capable of a *Heptagon*, the ſides of which ſhall be each of them equall to the line given *A. B.* as the extent of the uppermoſt prick'd line from the Center 7. plainly points forth.

And ſo adding part after part upwards, numbring them from the Center *C.* as 5,6,7,8,9,10, 11,&c. each point will be a Center (that if you extend your Compaſſes to cut at *A.* and *B.*) to deſcribe a Circle capable of a Polygon of ſo many Angles as is inſcribed on the ſeverall Centers, making the line *A. B.* equall to the ſides of each Polygon as was required.

Now I ſhall proceed to the Fortification of theſe ſeverall Polygons.

PLATE II.

To fortify an Equilaterall Triangle.

Let *A. B. C.* be a Triangle given to be fortifyed; divide one side thereof (as *A. B.*) into 8 equall parts, give 4 parts to the Curtain, and 2 to each Gorge, and at the extent of each end of the Curtain, erect the Flankes perpendicular to the Curtain, giving them one part, as *D. E.* and *F. g.* then draw the line *C. D.* from the Angle of the Shoulder to the Angle of the Polygon; also draw the lines, *E. F.* and *g. h.* and that proportions out the Angle of the Shoulder, and the Angle flanked, and consequently the whole Bulwarke.

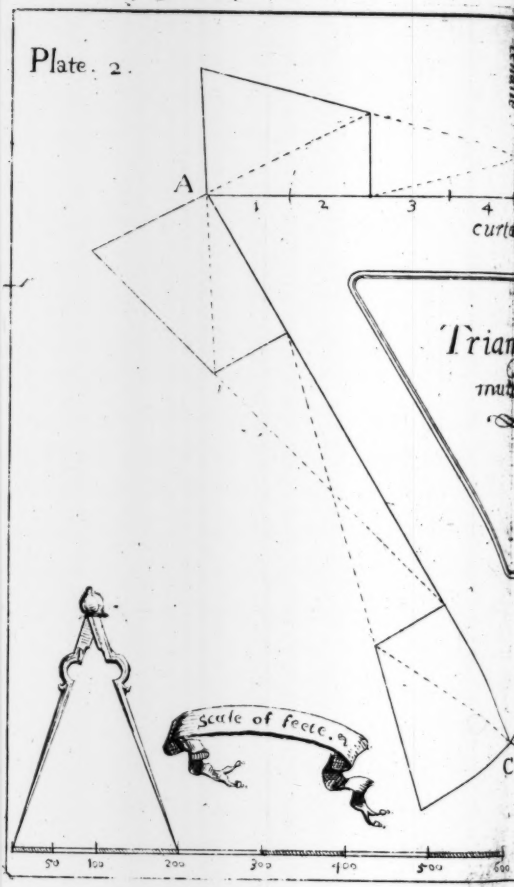


Plate. 2.
A
1
2
3
4
curta
Trian
inuti
Scale of feete.
50
100
200
300
400
500
600

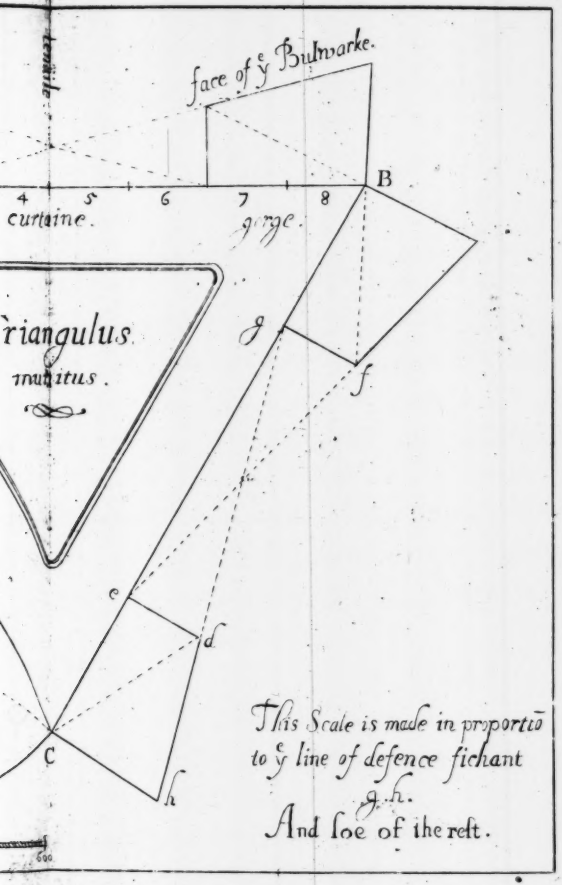

face of ye Bulwarke.
B
4
5
6
7
8
curtaine.
gorge.
riangulus
inuitus.
g
f
e
d
C
h
This Scale is made in proportō
to ye line of defence fichant
g. h.
And soe of the rest.

PLATE III.

A Square Fortreſſe.

Let there be a Square Fortreſſe *A.* divide the line *N. O.* into 6 parts, give *D. I.* the Curtaine, 4 of them, the Flankes, *C. D.* and *F. I.* each of them one part, the Gorges *D. N.* and *I. O.* one part alſo; then the line of defence running from the angle of the Flanke *I.* and cutting at the extent of the other flank on the angle of the ſhoulder at *C.* cuts the Semi-diameter *M. B.* at *B.* forming the face of the Bulwark, &c. as the figure ſheweth.

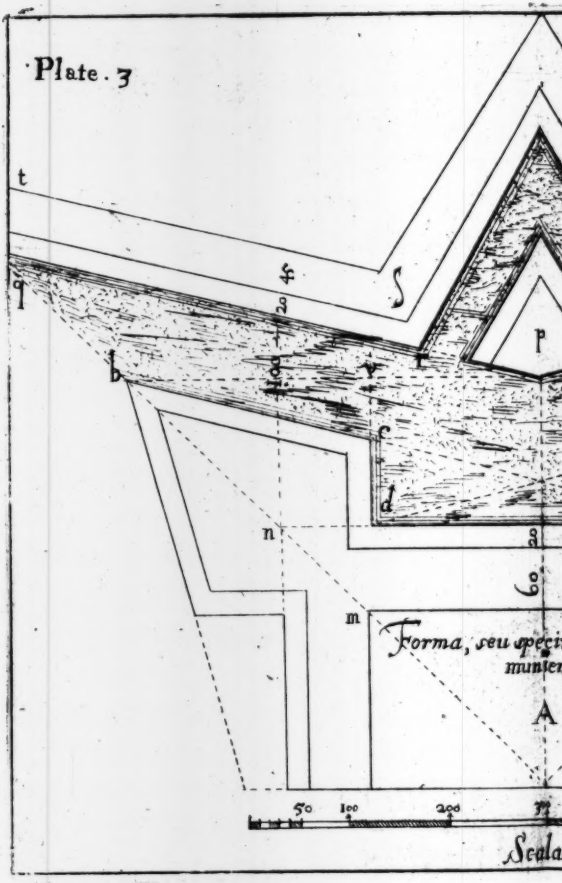
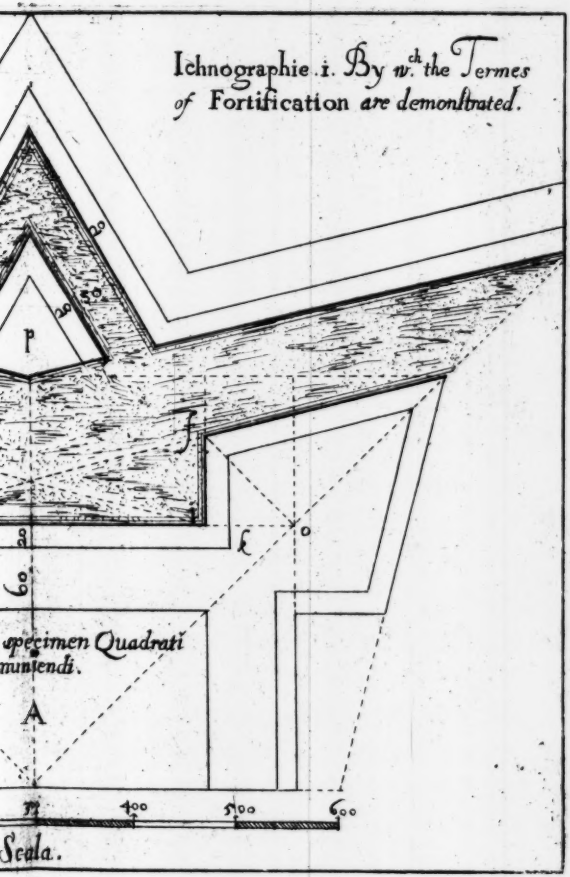


Plate. 3
t
q
b
c
d
n
m
p
A
50
100
200
Forma, seu speci
munier
Scala


Ichnographie .i. By w.ch the Termes
of Fortification are demonstrated.
P
f
a
b
o
c
A
specimen Quadrati
muniendi.
m
400
500
600
Scala.

XUM

PLATE IV.

To fortify a *Pentagon*, or figure of five Angles, and ſides.

In the *Pentagon*, or *Fortreſſe* with 5 Bulwarks, let the line *k. l.* be 63 rods, and divided into 7 equall parts, whereof the Capitall line *l. e.* is two parts, excepting one fift part of one of thoſe parts. Alſo the Capitall line *k. a.* and at the diſtance of two of thoſe parts, at each end of the line, as from *k.* to 2, and *l.* to 5, let fall perpendiculars on the line *A. E.* as the Flankes 2 *B*, and 5 *D*. then on the Angles *k.* and *l.* place the Angle of the Bulwarke, (which is alſo called the Angle flanked) 69 degrees according to the precedent Rules. And that ſhall cut off the flanke at *F.* and bring the line of defence in towards the middle of the Curtain, as at *C.* allowing good room for firing.

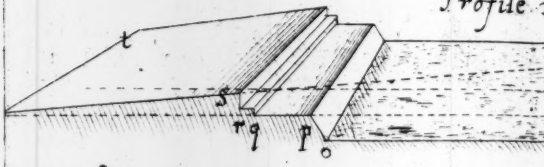
The profile on this plate, is accommodated with letters for the explanation of the *Termes* of *Fortification*, and not denoted with dimenſions as the ſequent are, yet is the ſhape ſufficient information for the ingenious.

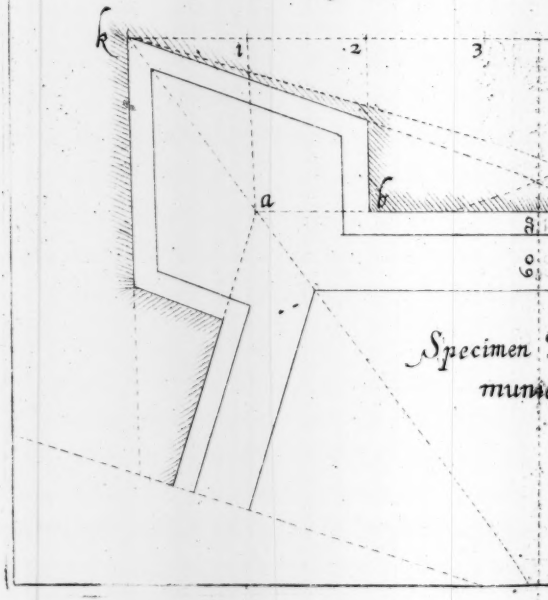
PLATE

Plate. 4

Pentagon

Profile



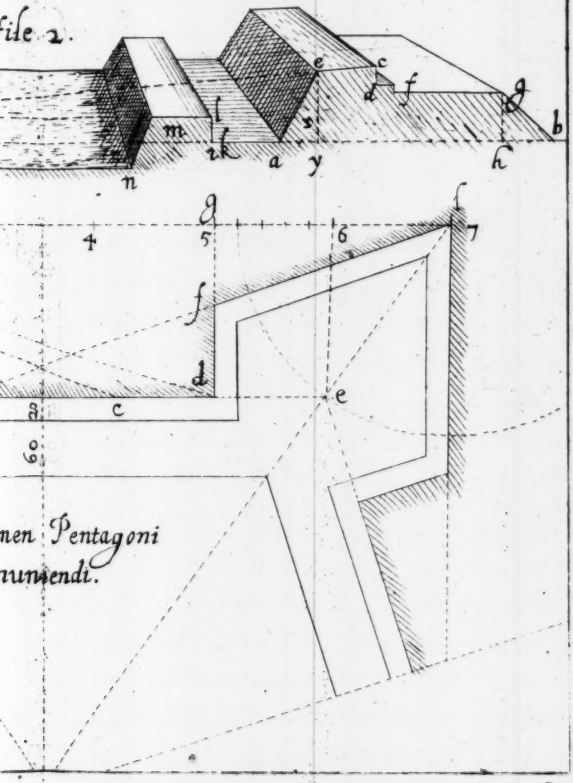


Specimen

mun

gonus.

file 2.



nen Pentagoni
vumendi.

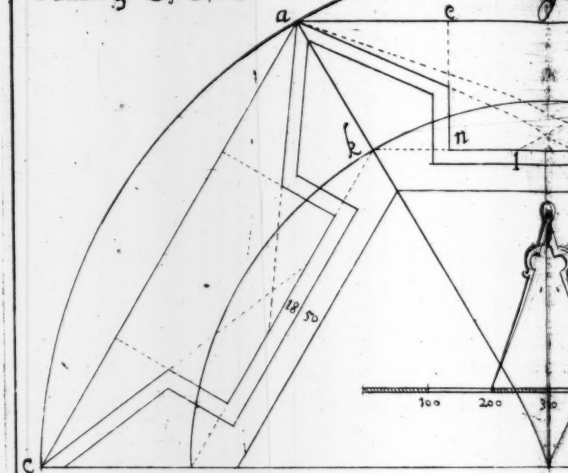
PLATE V.

To fortify a *Hexagon*.

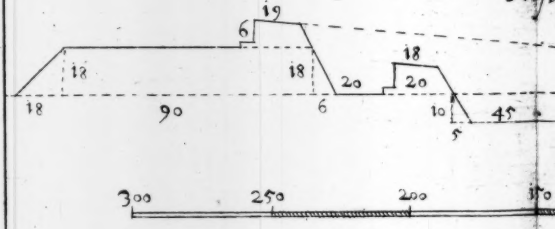
Deſcribe a Circle, (as the Semi-circle *C. A. B. D.*) and therein with the diſtance of the Semi-diameter, deſcribe a *Hexagon*, and divide the line *A. B.* (one of the ſides of the *Hexagon*) into 7 parts, and at the line *F.* being one part thereof, let fall a perpendicular, which cutting the Semi-diameter at *I*, gives the length of the Capitall line. Alſo at *E.* and *g.* let fall perpendiculars, and they ſhall proportion out the lines of the Flankes, and the length of the Curtaine. Then on the points *A.* and *B.* deſcribe the Angles of the Bulwarkes, according to the former Rules of calculating (being 82 degrees and ½) and that cauſeth the lines of defence to come in on the Curtaine at *L.* and *M.* allowing good room to fire. Laſtly, draw another Circle from *I*, through *k.* and ſo you ſhall find the reſt of the ſides of the *Polygon*. And conſequently the reſt of the Bulwarkes in the ſame manner.

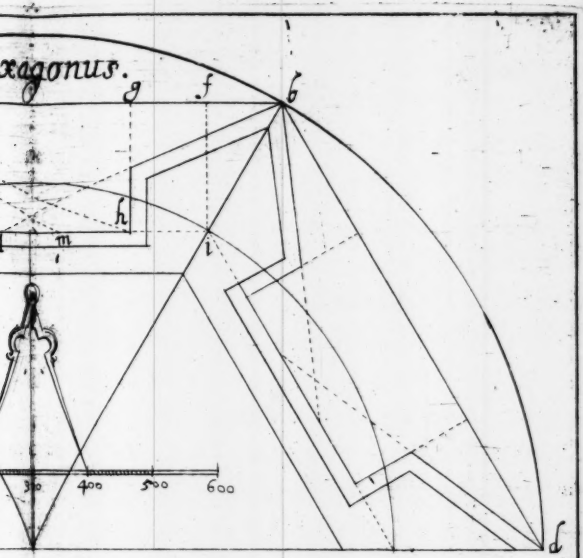
Plate. 5

Hexag



Profil

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f
b
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300
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Profile.

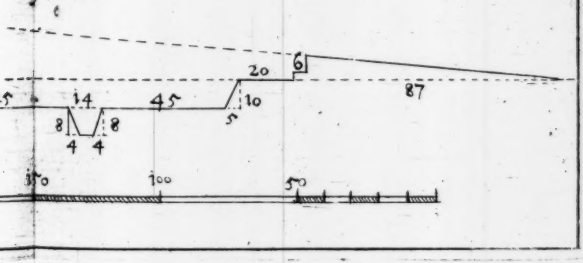

20
6
87
14
45
10
8
8
4 4
5
150
100
50

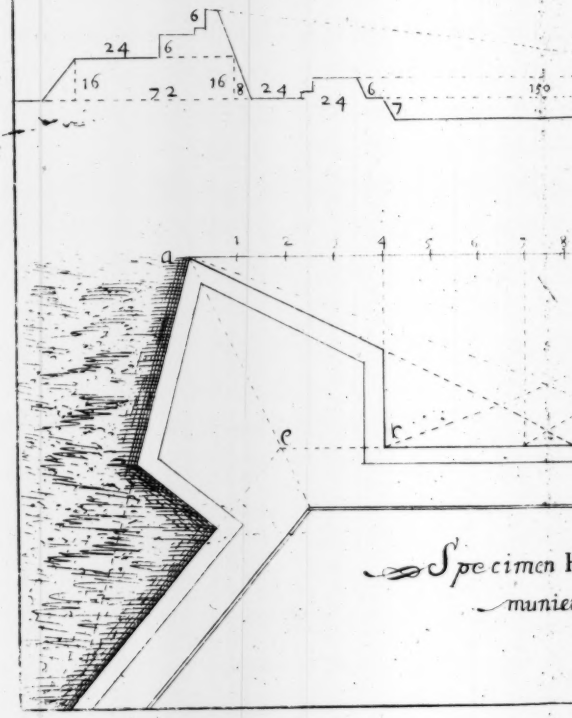
PLATE VI.

To fortify a *Heptagon*.

Divide the line *A.B.* into 15 parts, and at the distance of 4 parts thereof, from the extents *A*, and *B*, let fall perpendiculars, as the lines 4 *C*. & 11 *D*. each 4 parts in length, the basis of the oblong being drawn and extended to the Semi-diameters, marks out the Centers of the Bulwarks at *E*. and *F*. then on the Angles *A*. and *B*. describe the Angles of the Bulwarke of a *Heptagon* (being 79 degrees and $\frac{3}{7}$) & that shall form your Bulwarks, the Angles of the Shoulders, and the length of the Flankes.

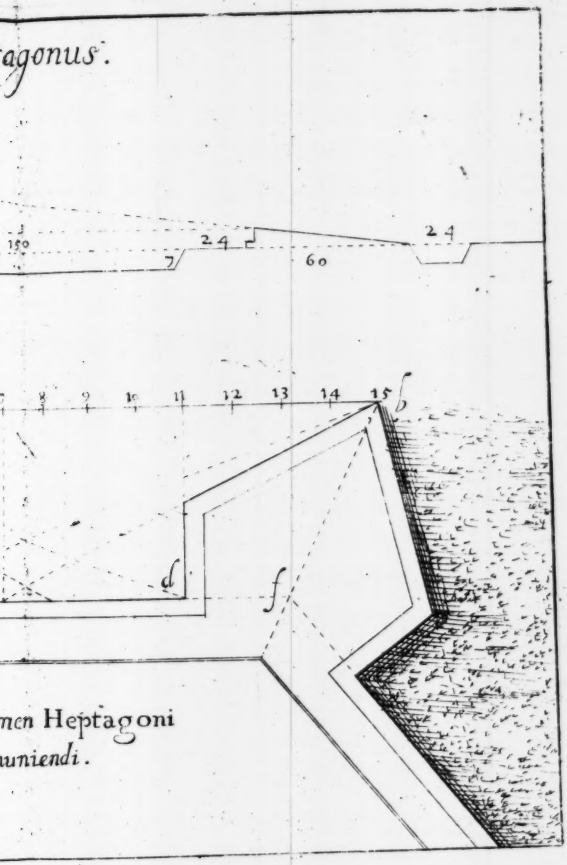
Plate. 6.

Heptagon



Specimen
munie

agonus.



nen Heptagoni
uniendi.

PLATE VII.

To fortify an *Octogon*.

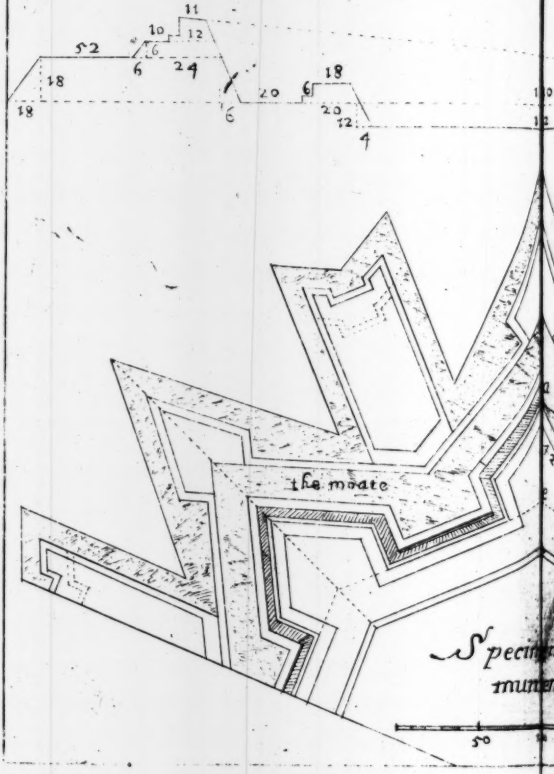
Divide the line *A. B.* into 7 equall parts, allow three parts thereof for the length of the Curtain, and two parts at each end, for the extention of the flankes, which are thus to be found. At the diſtance of two parts from each end of the line ſo divided *A. B.* draw down two lines perpendicular to the ſaid line *A. B.* and at the length of two parts placed on the lines 2 *C.* and 5 *d.* cloſe up the ſquare, 2, 5, *C. D.* the baſis whereof *C. D.* being protracted to the Semidiameters, will cut at *e.* and *f.* (as before) making them the Centers of the Bulwarks; then on the points *A.* and *B.* deſcribe Angles of a Bulwarke of an *Octogon*, as the former rule of Calculating directs, & that wil give you the Angle of the Shoulder, and the length of the Flank, &c. as the figure moſt plainly demonſtrates.

The outer Horn-works, Ravelines, Halfe-moons, and Counterſcarfes, deſcribed with this figure of the *Octogon*, are to be added to any of the other Fortreſſes in the ſame kind, according to the diſcretion of the Engineer, and as the neceſſity of the place requires.

Theſe eight deſcriptions ſhall ſuffice for a direction

Plate. 7.

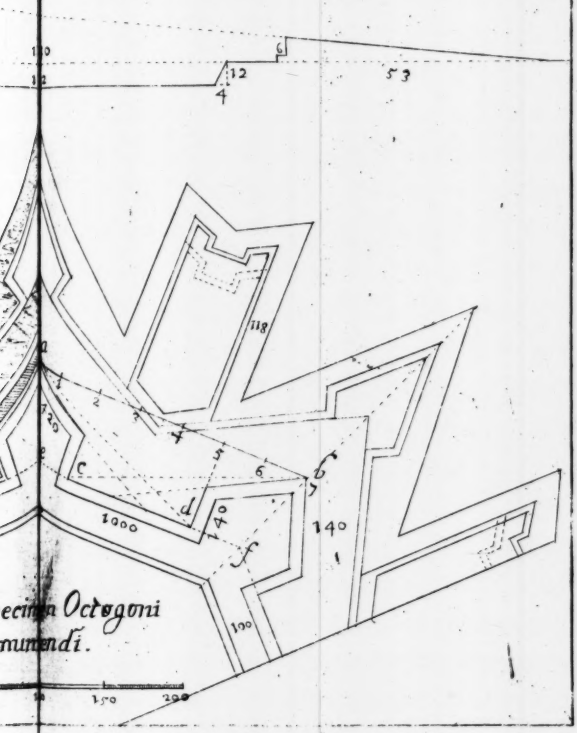
Octag



Specim
mum

50

ctogonus.



ecinta Octogoni
mundi.

direction to fortifie Regular *Polygons*. If further occaſion proffer it ſelf, I conceive the precedent rule of calculating, (extending to all Figures, of how many Angles ſoever) with the experience gained by the ſtudy of theſe eight, will make all others facile to the ingenious.

An exact Table of Calculations,

For the deſigning of Forts, and regular Bulwarkes, from a *Foure-ſquare* to a *Dodecagon.*

In a Foure-ſquare.

	Deg.
The Angle of the Polygon.	90
The Angle of the Bulwarke.	60
The Angle of the Center.	90
Angle flanking Exterior, called the Tenaile.	150
Angle flanking Interior.	015
Angle of the Shoulder.	105

A Pentagon or five Angled Fortreſſe.

	Deg.
The angle of the Pol.	108
The angle of the Center.	072

The ang. of the Bul. called the Ang. flanked.	069
The ang. flanking Interiour.	019 1/2
Ang. flanking Exteriour.	141
Ang. of the Shoulder.	109 1/2

A Hexagon.

	Deg.
The ang. of the Pol.	120
The ang. of the Center.	060
The ang. flanked.	075
The ang. flanking Exteriour.	135
The ang. flanking Interiour.	022 1/2
Shoulder.	112 1/2

A Heptagon.

	Deg.
Ang. of the Pol.	128 4/7
Ang. of the Center.	051 3/7
Ang. flanked.	079 2/7
Exteriour, or Tenaile.	130 5/7
Ang. flanking Interiour.	024 2/14
Shoulder.	114 12/14

An Octogon.

	Deg.
Ang. of the Pol.	135
Of the Center.	045
Ang. of the Bulwark.	082 1/2
Ang. flanking Exteriour.	127 1/2
Interiour.	026 1/4
Shoulder.	116 1/4

An Enneagone.

	Deg.
Angle of the Pol.	140
Center.	040
Ang. of the Bulwark.	085
Ang. flanking Exteriour.	125
Interiour.	027 1/3
Shoulder.	117 1/3

A Decagon.

	Deg.
Angle Pol.	144
Center.	036
Bulwark.	087
Angle flanking Exteriour, or Tenaile.	123
Interiour.	028 1/3
Shoulder.	118 1/3

An Undecagon.

	Deg.
Angle of the Polygon.	147 3/11
Ang. of the Center.	032 8/11
Angle flanked, or Bulwark.	088 7/11
Angle flanking Exteriour.	121 4/11
Interiour.	029 7/33
Shoulder.	119 7/33

An

A Dodecagon.

	Deg.
Angle of the Pol.	150
Of the Center.	030
Ang. of the Bulwark.	090
Ang. flanking Exterior.	120
Interiour.	030
Shoulder.	120

So far being as much as is probable to be uſed.

It follows now that I explain the deſcription of one that is *Irregular*; that is, conſiſting of unequall ſides and Angles, by which you may be informed to fortifie any *Irregular* forme whatſoever.

PLATE VIII.

To fortifie a forme *Irregular*.

To demonstrate this, let the Irregular *Pentagon*, *A*, *B*, *C*, *D*, *E*. be the ground whereon to work it, the side *A*, *B*, being 720 foot, the side *B*, *C*, 491 foot, the side *C*, *D*, 657 foot, *D*, *E*, 604 foot, and the side *E*, *A*, 773 foot, the which figure being drawn according to these severall dimensions, by that *Geometricall* Instrument, the *Quadrant*, examine how many degrees each Angle doth contain. Let us first endeavour to fortifie one Angle thereof, to wit the Angle *A*.

The Angle *A*. contains 120 degrees, which is the same with the Angle of a *Hexagon*; and therefore this Angle requires to be fortified in the same manner as an Angle of a *Hexagon*. But it is to be regulated proportionable to the lesser Curtain, which in the *Hexagon* containes 900 foot, the *Gorge* 180 foot, and the *Flank* 140. Then by the Rule of Three put the question: If the Curtain being 900 foot long, gives 180 for the Gorge; how many shall 720 foot give? and so shall you find 144 foot for the length of the *Gorge*, as is here denoted.

Again, If 900 foot Curtaine gives 140 foot Flank; what gives 720. foot? So shall you find

112 foot to be the length of the Flanke.

And again, 900 foot Curtaine, gives 380 for the Face; what gives 720 foot? and we find 304. foot.

The angle *B.* contains 88. degrees, and ½, and is neareſt in contents to a *Quadrate*, wherefore the Bulwarke to be placed thereon, muſt be in form like unto that of the foure-ſquare, being guided by the ſhorteſt Curtain, and ſo the reſt, were they never ſo many. And though this figure conſiſts but of few; yet they are too many to be all demonſtrated in this ſhort intended diſcourſe.

On the ſame PLATE 8.

Is figured ſeverall ſizes of Gabions, or Cannon-baskets, which being filled with earth are often uſed in the place of a *Parapet*, on Batteries: they are placed a little diſtance one from the other, for the Cannon to play out between. And ſometimes in the Field they are ſet one behinde another, as the figure *B.* in the 12 Plate demonſtrates.

There are uſually three ſorts of *Gabions*, the meaneſt and ordinary, are 6 foot high, and 3 foot over, the middle ſize 7 foot high, and 5 in Diameter, and the greateſt which are called double *Gabions*, are 10 foot high, and 7 foot wide, as in the figures are expreſſed.

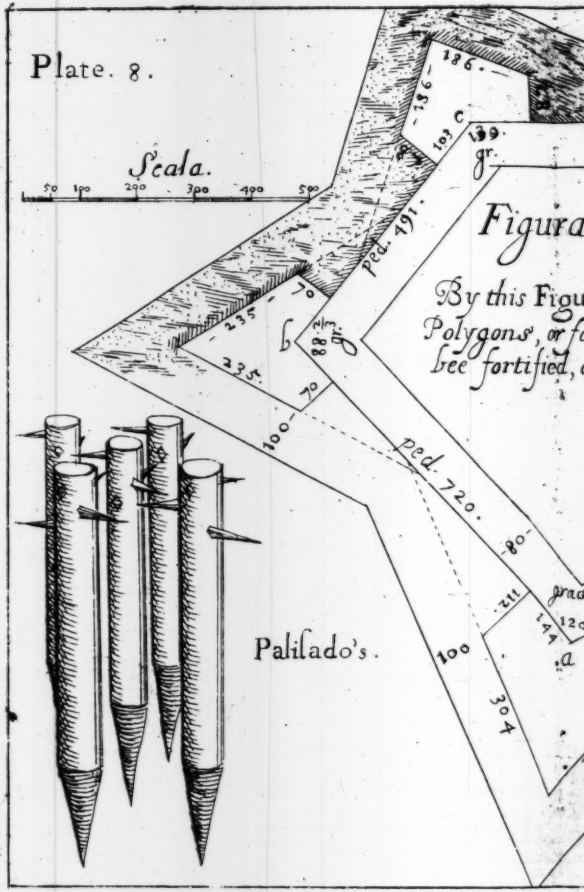
On the ſame PLATE 8.

There is alſo expreſſed the form of the *Palliſadoes*, wherewith the Avenues, or entrances of quarters (in the night ſeaſon) are ſecured: being driven into the earth three or four rows of them, cloſe one behind another, to the height of 3 foot, or 3 foot and an halfe. The firſt and outmoſt row muſt be driven in deepeſt, that the Iron-ſpikes of the next may entangle them in that manner, that they may not be drawn forth by any aſſailant. They are commonly made of good ſpars ſome two inches and an half in diameter, and about five or ſix foot high: headed with Iron at the points, for the eaſier piercing of the ground. They have 3 great ſpikes, or Nailes of Iron driven through them in the top, which are about 8 or 9 inches long, in manner and form as the figure doth ſhew unto you.

But the Avenues of ſetled Garriſons, are moſt frequently ſecured by *Turn-pikes*, in the firſt place of defence, or oppoſition. And they are made as is deſcribed by the figure marked *E.* in the next plate.

PLATE

Plate. 8.


Scala.
50 100 200 300 400 500
186.
136.
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gr.
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By this Figu
Polygons, or f
bee fortified,
ped. 491.
70
235.
b
88 gr.
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80.
112
144
120
a
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304
Palisado's.

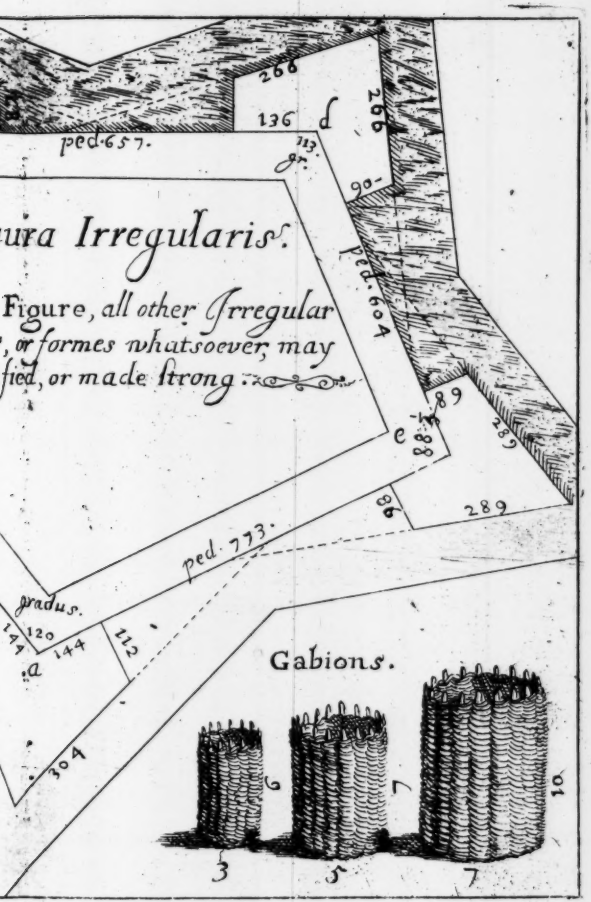

ura Irregularis.
Figure, all other Irregular
, or formes whatsoever, may
fied, or made strong.
ped. 657.
136
113
gr.
266
266
90
ped. 604
289
289
289
98
ped. 773.
gradus.
144
120
144
112
a
304
Gabions.
6
7
10
3
5
7

PLATE IX.

The Figure marked

A.

Preſents the form of a Saucidge, the uſe thereof is, to ſecure the foundations of Workes in Mooriſh and Quagmiry grounds; they are made as followeth.

Firſt you muſt drive ſtakes of a competent length, and at a reaſonable diſtance, as your Saucidges, either for their greatneſſe, or ſmalneſſe ſhall require. Either one foot high, 1 foot and ½, or ſometimes two foot in height.

Then between theſe ſtakes you muſt depreſs bundles of ſmall bruſh wood, bound faſt together: Filling them in the midſt with brick-bats, if you would ſinke them in a River; but with earth, if you intend them a foundation in a Moat all along the ſaid Work.

If any water beat impetuouſly on any part of your Works, or that your ground be ſandy, and your Moat of that depth that it be filled with water: all ſuch Workes muſt be faced with ſuch Saucidges, to hinder the waters concavations, for want of which I have ſeen great parts of Works Calve ere they were finiſhed.

B. PLATE 9.

Demonſtrates the ſecret diſpoſing of the ſods in the raiſing of a *Parapet*. The baſis or underſides thereof lie levell, and their taprings are made up and level'd inwardly with earth, by which means the earth and the ſods come to incorporate, and become as one; the which if the ſods were of a like thickneſſe throughout, would make a ſtraight joynt, from the top to the bottome of the *Parapet*. The which in a ſhort time would ſeparate from the main Coare of the *Parapet*: as I have ſeen it in ſome places.

C. PLATE 9.

Is a *Triangular* inſtrument very expedient (in the laying of the turffes) to give each *Rampart*, *Curtain*, or *Parapet*, its due *Talud*, or ſloop. It is to be made of Wainſcot, or good Oaken board, that is clean from knots; making the longeſt ſide thereof, ſome 3 or 4 foot in length, hanging thereon a Plummet, whoſe line being parallell to the ſide of your inſtrument, directs the *Perpendicular*, the upper ſide may be protracted, or contracted, according to the Talud, or ſloop required.

D. PLATE

D. Plate 9.

Shows the ſhape of the ſod, or turffe it ſelf, which is ordinarily 4 or 5 inches thick at the head; the breadth is to be 15 inches or thereabouts, and they are 14 or 15 inches long, diminiſhing inward for the reaſon aforeſaid. In the the laying of the turffes care muſt be taken to break the upright joynts, which (to ſpeake workman-like) is, to make good bond, the bond and ſtrength of the work conſiſting much therein.

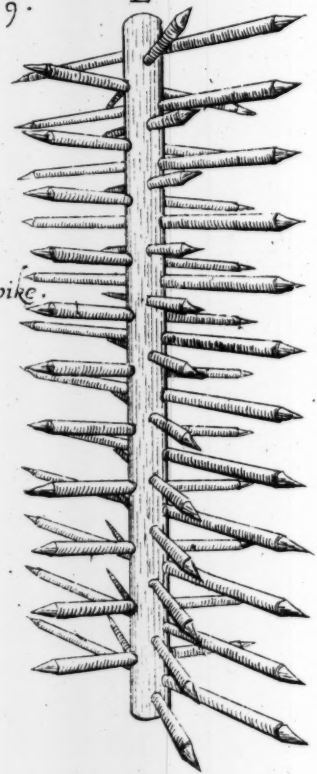
E. Plate 9.

To make a Turn-pike.

You muſt take a round Sparre of wood, ſome 12 or 13 foot long, and halfe a foot diameter. Divide the Circumference thereof into 3 equall parts, and ſtrike 3 lines *Perpendicularly* along the peece. Then divide the ſaid peece length-ways into ſo many parts, as that the ſaid diviſions be not above 3 or 4 inches aſunder. At which ſeverall diviſions you muſt bore holes through the peece, one under another, but ſo alternately that they paſſe not one through the other. And therein (to wit) in every

Plate. 9.

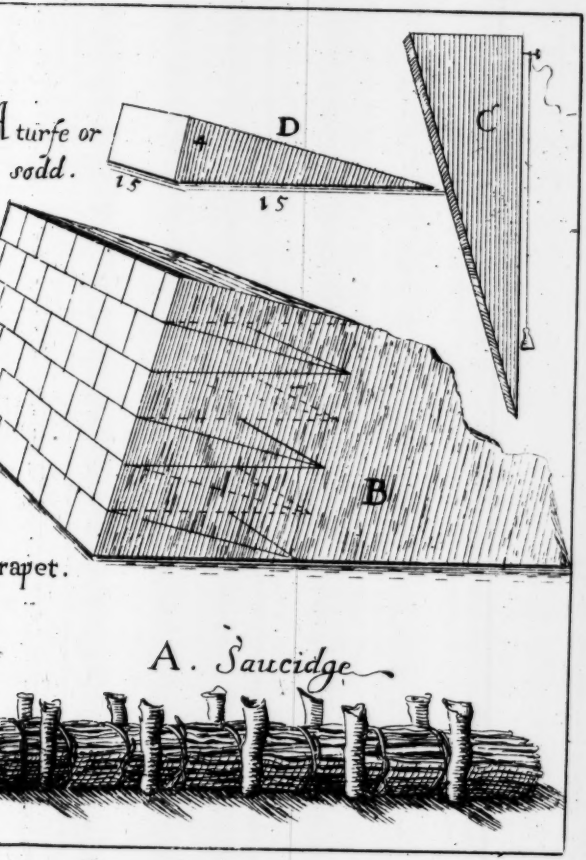
E



A
Turne-pike.

A turf
soda

Parape


turfe or
sodd.
D
C
4
15
15
B
rapet.
A. Saucidge

every hole ſhall you faſten a *Demi-pike* of 6 foot in length, headed with Iron at both ends: the which being faſtned to the Sparre juſt in the midſt, their points will extend to a *Hexangular* Figure. They are of very good uſe for defence againſt horſe.

The ſame may be alſo made to runne upon wheeles, and are neceſſary to ſtop a paſſage into the Campe', to ſtand at the entrance into a work, or upon a gap of a work.

PLATE

PLATE X.

How to fortifie a Square-Fortresse with a *Tenaile*.

Of Square Fortresses, those (in my opinion) whose Angles of the squares are so far distant, that they shall need a Bulwark in the midst of the Curtain, are to be fortified with a *Tenaile*, which is: (in stead of placing the square-pointed Bulwarkes on the Angles of the *Polygon*, (as is before demonstrated) to make the Angles *B, C, D. F, G, H. K, L, M,* and *O, P, Q,* in the middest of the sides of the square, *A, E, N, I,* so that the lines which forme the Tenailes be all alike amongst themselves; as, *A, B, C, D, E, F, G, H, I, K, L, M, N, O, P,* and *Q,* and the Angles also equall one unto the other, which is done by drawing the 2 diagonall lines *A, I,* and *N, E;* which cut through each other in the Center *R.* Then placing one foot of your Compasse in *A*, and extending the other to *R.* describe the Arch *D, O,* and with the same distance *B, H, F, M, K, Q*, and finally having made the Angles *D, C, B,* Isocles and the rest: the Angles of each *Tenaile* do form a figure *Octangular*, consisting all of Right-angles, which afterwards may be made

Angles

Angles of a Bulwarke, if it be required to be converted into a Fort-Royall. If that the diſtance from angle to angle be large enough in extent, that is to ſay, of 60 rod in length, and upwards to 80, otherwiſe it cannot attaine to ſuch perfection, as to be a Fort-Royall. But if ſo be the diſtance of Angles be capable of a perfect fortification, then you may make the Plot as followeth.

In the ſame, PLATE X.

To convert a Square Fortreſſe, formerly fortified with a *Tenaile*, into a *Fort-Royall*.

Let the line *e. g.* be drawn, and divide it into 3 equall parts. Place 2 of thoſe parts upon the line *H, G*, as here at *S*. And from the points *S*, and *I*, of the diſtances *I, G*, and *G, S*, alternate, ſhall bee made the Arches which cut through one another at the point 4, by which the line *G*, 4. being drawn, where the ſame cutteth the line *H, I*, at the point 2, will be proportioned out the line *I*, 2, for the face of the Bulwark. To finde the Flankes, the Angle *X. V. I.* muſt be made of 40 degrees, by the line *X. V.* paſſing through the point 2, and cutting the Diagonall *I. R.* in the point *X*, which ſhall

ſhall be the Center of the Bulwark. Through which a line being drawn, parallel to *I*, *G*, as is the line *X*. *X*. And from the point 2, a *perpendicular* being let fall upon it, as *y*. 2, you ſhall have all the eſſentiall parts of this fortification, *viz*. *I* 2. the face, 2 *y*. the Flanke, *y*. *x*. the line of the Gorge, *Z*. *I*. the line of defence flanking.

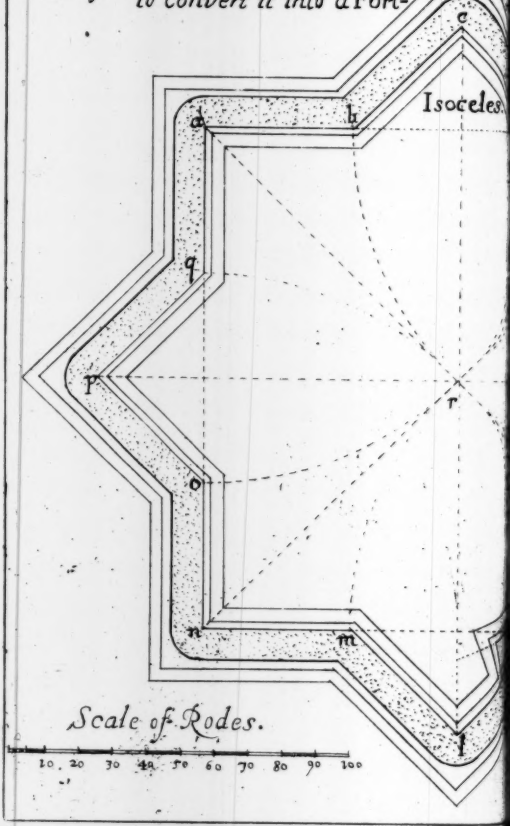
And becauſe that in ſuch places no *Falſe-brayes* can be made without great expenſe; in regard they muſt be made on the outſide of the *Ramparts*, and alſo on the other ſide of the Moat muſt neceſſarily be made a *Covert-way*, according to our former plots, and profiles in default whereof, that your men may give the better reſiſtance to the aſſailants, as appeareth by the figure.

A. Plate 10.

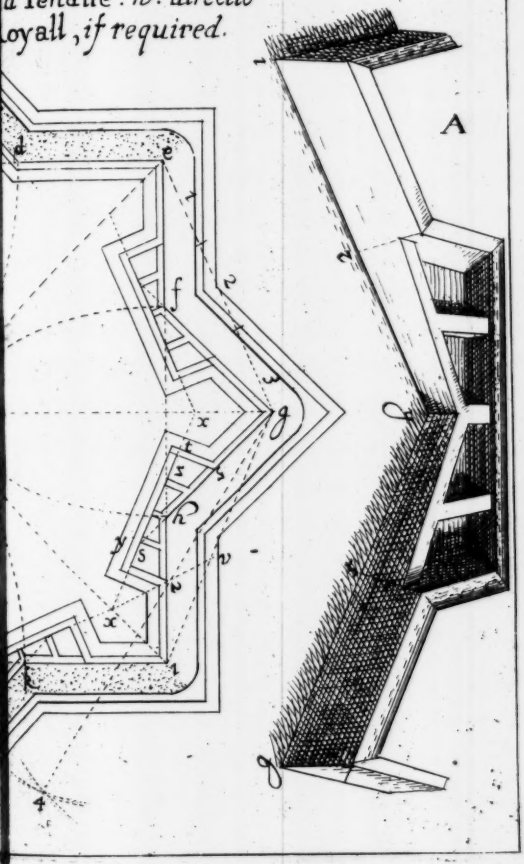
You may make a good *Parapet* (which ſhall runne down ſlooping) being about 20, or 24 foot thick, with traverſes between *h*. and 5. riſing one above another, behind which you may lodge Muſquetiers very conveniently. As alſo 2 peeces of Ordnance, from whence (inſtead of Caſemats) you may beat upon (and break) the enemies gallery when he ſhall offer to put it into the Moat. And many

Plate. 30.

A Square fortresse, *fortified* ... *to convert it into a* Fort-



a Tenaile . n^{th}. direction
oyall , *if required.*



many more conveniences will arise in defending any breach in the Bulwarke more then if there were a *False-bray*, as the figure demonstrates, and the ingenious may easily discern, by laying the point *I.* and the point *G.* in the Figure *A.* on the point *I.* and the point *g.* in the other Figure.

PLATE XI.

A.

Shews to run Approaches to a Fort.

When you intend to myne under either Bulwarke, or both; you ought not to break ground no nearer then within muſquet ſhot, or at the fartheſt, as far as a harque-buſſe can reach: At your firſt entrance into the Trenches, or Approaches, ye make a ſquare Work or two, called Redoubts, being diſtant one from another ſome 40 or 50 rod. In them you muſt place ſtrong guards; to the end, that if the enemy ſhould ſally out upon the Trenches, that by the ſame they may be beaten back. Every ſide thereof ought to be 4 or 5; or at the moſt 6 rod, and the ditch broad and deep as neceſſity ſhall require. Theſe Redoubts ought to be made, that the 2 oppoſite Angles may enfile the ſaid Trench, as appears by the figure—

—*D.* PLATE II.

For then the ſaid Trenches will not only lie open unto it, but alſo one may diſcover the fields round about it.

Demon-

Demonſtration.

A. is a fortreſſe to be approached unto by trenches, *P. Q.* are two Bulwarks, *a.* is the beginning of the Approaches: *A. B.* the firſt trench or line; where the Pioners break ground, carried in ſuch a manner towards the Angle *R.* that if the line were lengthned, it would runne without the point *R.* In the Angle *B.* muſt be made a Court of guard, for the aſſurance of thoſe which guard the trenches. From *B.* towards the Angle *S.* is made a line, which is drawn in the ſame manner, that if it be lengthned, will fall on the out-ſide of the Bulwarke *Q.* which is continued as farre, as to the *Parapet* of the *Covert-way*, at *I.* where one begins a Myne to blow up the *Counterſcarſe*, that ye may come to the brinke of the Moat. From *D.* is drawn the line *E. K.* to the ſame purpoſe as before: and to be the better aſſured of the endoſure *K. E. I.* Betweēn *K. E.* and *I. E.* (before you come to pierce through with your ſappe) you ought to make the lines *L. O.* and *F. M.* that from thence you may give fire on the enemies Muſquetiers, ſetting along upon theſe lines Muſquet baskets, that you may play continually upon the beſieged, that under the favour thereof, you may advance your ſaps towards the faces *R. T.* and *V. S.* as the ſaid figure ſhews.

B. Plate II.

Is the *Ichnographie*, or ground-deſcription of a battery, which are commonly made when the trenches of Approach are begun, that under the favour thereof, your men may work forward with the more ſafety, and hinder the enemies falling out upon them, which would much for-ſlow your work. Theſe batteries, and plat-forms are made according to the greatneſſe, and number of your Peeces; for a Demi-cannon being ſhorter then the whole, of neceſſity the plat-form of the one, muſt be longer, and deeper then that of the other: And ſeeing a whole Cannon, being mounted on its Carriage, is ſome 16 or 18 foot long; it is evident, that the batteries ought to be made for recoyling at leaſt 10 or 12 foot longer, making together 28 or 30 foot; the firſt 12 or 14 foot muſt be planked, and the reſt floored with hurdles. The dimenſions on this figure placed, formeth a battery for 4 peeces of Cannon: the ſame forme is to be proportioned to the neceſſity of the occaſion.

C. Plate II.

Is the Profile of a battery, ſhowing how i

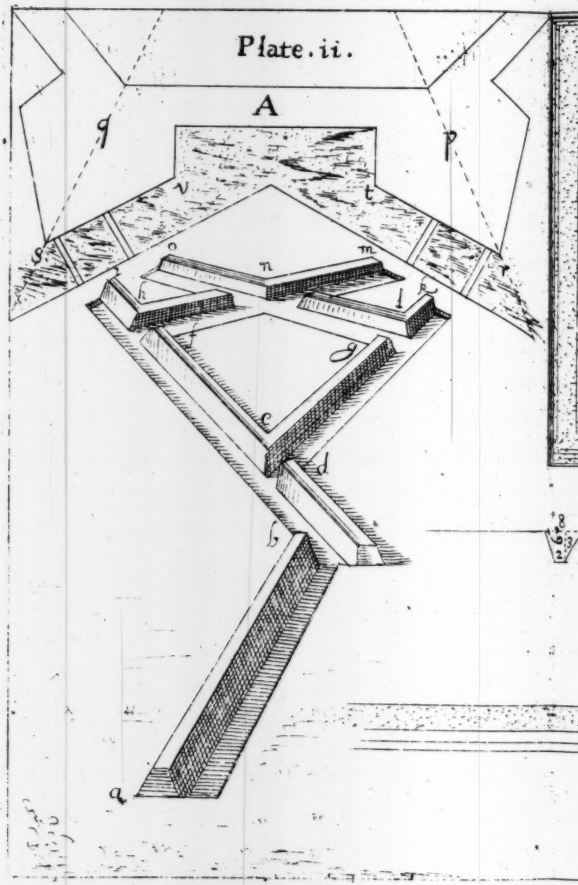


Plate. ii.
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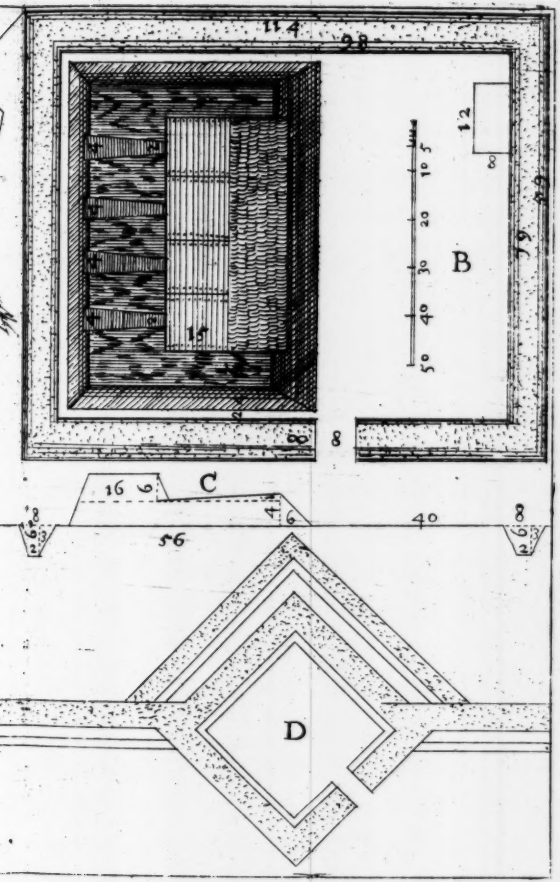
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D

it is elevate from the Terra-plain, with the depth of the ditch, which encloseth it. Also shewing that the hinder part of the Platform is elevated above the fore-part, both to resist the recoyl of the Peece, and also that it may with the greater ease be drawn forward again.

PLATE XII.

How to pierce through a Counter-ſcarfe, and to make a gallery over a Moat.

A.

When you are come with your Sap, to the *Parapet* of the *Covert-way*, then you muſt make batteries to beat down the flankes, and other places of defence of the Fortreſſe. And then begin withall to pierce into their Counter-ſcarfe; and for the better effecting thereof, if it be high, you muſt make an entrance into it through a Myne, as *G. H. I. K.* and *F. L.* in the figure *C.* demonſtrate.

Being gotten through the Counter-ſcarfe, and come to the edge of the Moat, preſently caſt abundance of fagots, bruſh, and earth into it, to fill it up; thereon place your gallery.

D. PLATE 12.

Is the pattern of a Gallery, to be made of Oaken planks, ſupported with ſquare frames of timber, 8 foot high, and 6, 7 or 8 foot broad, for the larger it is the better it is, and the more men may march

march a front in it; the frames or ſupporters may be ſet 5 or 6 foot aſunder, according as your plankes will hold out for length, as from *A.* to *B.* and it is to be planked within and without, and the ſpace between, to wit, ſo much as the thickneſſe of the poſtes, being about 6 inches thick, muſt be filled with earth, to reſiſt the force of ſhot; and above on the top of the gallery, you muſt ſpread earth a foot, or halfe a foot thick, to keep it from firing.

E. PLATE 12.

Shows that when you have put over a gallery, (as is ſaid) then you muſt begin to myne, as you ſhall find the place to give beſt accommodation, either to your right, or left hand, high, or low; (if the water hinder not) myning and working as followeth;

The earth that is digg'd out of the Myne muſt be carried away through the gallery in wheel-barrows, whither you will: you may caſt it into the water towards the Angle of the Bulwarke, and ſo fill up the Moat with it. Mark well the turning of your Myne, to prevent Counter-myning.

A *Counter-myne.*

Counter-mynes are made in Ramparts or

Bulwarks, at the first new making of a Fort, being some 5 or 6 foot high, and 3 or 4 foot broad. In them the least noise that is made on the outside is to be heard, and which way they work, by which means you may hinder them the better from myning.

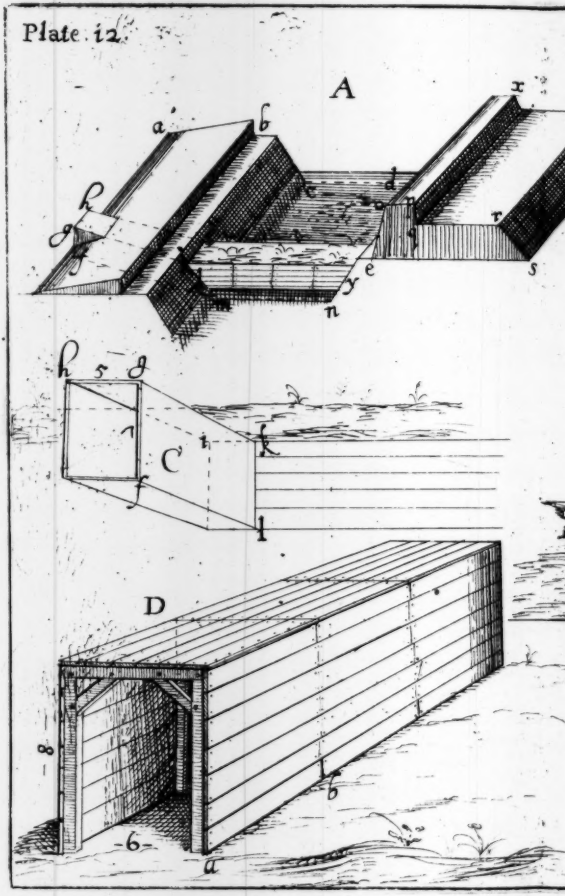
A *Myne*

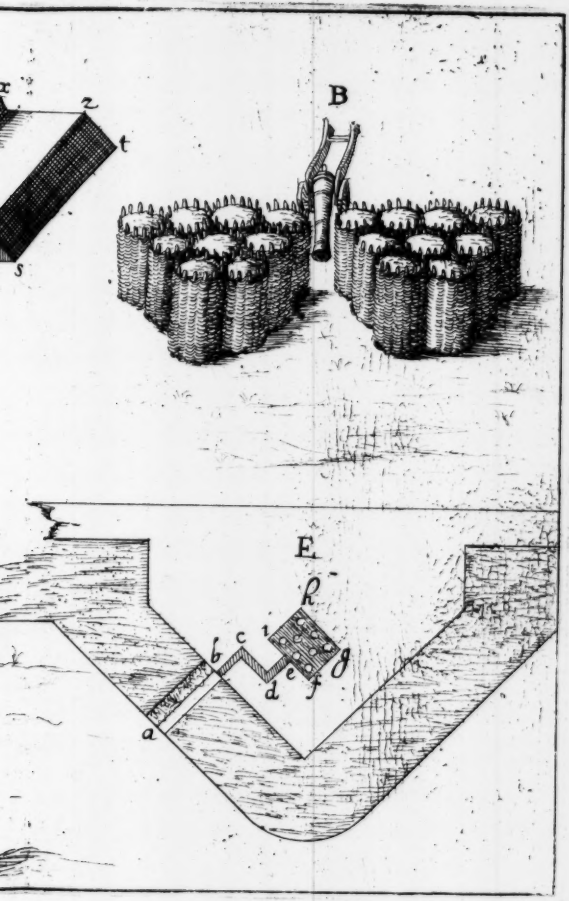
Is commonly made in the form of a *Parellelogram*, or a long *Square*; to wit, the chamber in which the powder is laid, must be 4 or 5 foot high, and 3 or 4 foot broad, and in length answerable to the ponderousnesse, or weight of the Bulwarke, and according to the breach which you intend to make. The entrance into the chamber must be but 4 foot high, and 3 foot wide, that it may be the easier stopp'd to hinder the exhalation from breaking out backwards.

Then having chambered your powder, and noted well that those within have not discovered it: you must stop, and shut up your myne exceeding firm, that it may take the better effect. To doe this, the best way will be to stop it at *E.* with 2 huge plankes, and at the said entrance at *E.* drive great spars of timber into the earth, to resist the recoyle of those planks, as firm as possible may be, it being of great concernment to the Work. The chamber

f. g.

Plate 12.

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f. g. and *H. I.* is 4 foot broad, and *g. h.* and *F. I.* 6 foot long. Oftentimes the breadth is but three foot, the better to be assured of the postes, and plankes resistance. In one of your plankes must be a hole for the train, that is to fire the powder, to enter the chamber, which runnes from *E.* to *B.* the turnings *B. C. D. E.* is made to delude the besieged.

Some are of the opinion, that a barrel of powder will blow up twelve foot of earth; according to which computation, you may make your chamber, and lay in as many barrels as you shall think convenient.

PLATE

PLATE XIII.

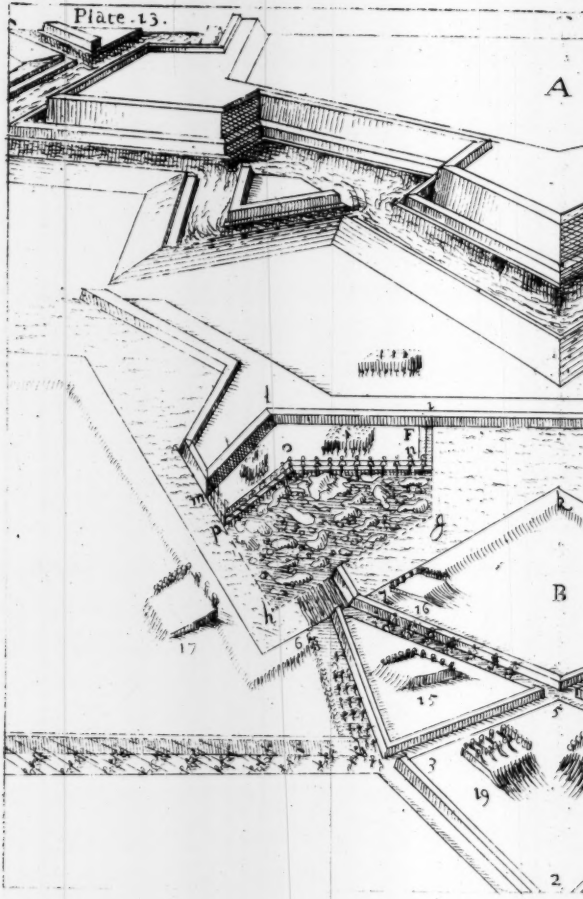
A.

Is a *Scenographicall Ortography*, or upright erection of a work in Prospective. To satisfie the curious what prospect a Fortresse yeildeth; being seen from aloft.

B.

Shows first how and in what manner batteries are to be raised, and where to be placed, which way they are to play, and for the more expedition, how the gabions are placed thereon in place of a *Parapet*: as the batteries 10, 11, 12, 13, 14, 15, 16, 17, 19, and 20, doe plainly demonstrate. Secondly, it teaches the Defendant, if an enemy be got into the skirt of a Bulwark, as *g. h.* to make him gain the place foot by foot, by making the cuttings of *F. L. M.* whereof *N. O. P.* is the ditch, making the Angle *l.* as much pointed, as possibly may be, that the line *F. l.* and *L. M.* may the better be seen from one another, carrying the outward edge of the ditch, *N. O.* and *P.* as near the skirt *g. h.* as possibly may be. If the whole face be not ruined, but only the angle of the Bulwark, as *R.* the angle *T.* from the Tenaile *S. T. V.* will be fittingest to be made, as a cutting off.

Plate. 13.



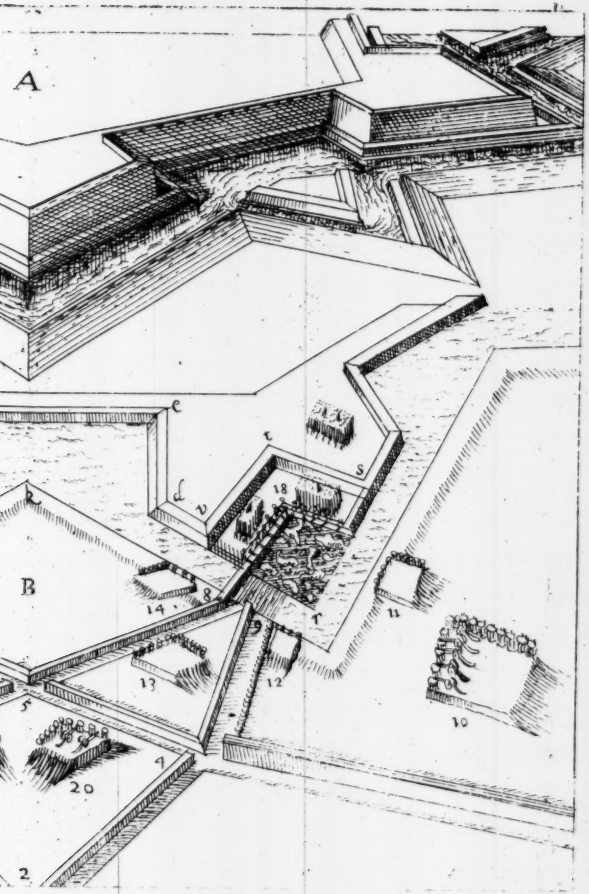

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PLATE XIV.

Shews the manner of Quarters for a Regiment of Foot.

K. L. M. N. O. P. is the Colonels lodging.

Q. R. S. T. his Kitchin and Stable.

H. I. the Captains lodgings.

G. the crutches, or forks, againſt which the arms of each company are ſet, in the head of the Huts of each company.

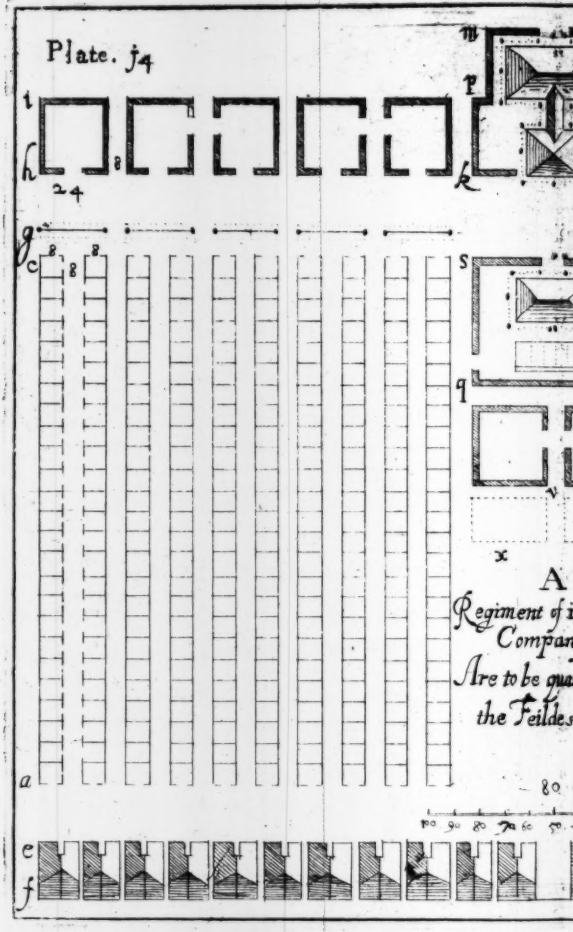
A. B. C. D. the Souldiers Huts, each file containing 25, each Hut 2 Souldiers, each company 2 files.

E. F. are the Sutlers Huts, which are made either larger, or ſtraiter, as occaſion ſhall require, leaving a little ſpace between each of them for their more freedome, and to prevent the danger of fire.

The Lieutenants, and Enſignes, have their Huts each in the head of their Company, whoſe entrance fronts to the Arms.

The Serjeants Huts open toward the Sutlers Huts, and are placed in the reare each of his own Company; and by the Sutlers, to prevent all diſorders that may happen.

The Souldiers Huts have their fronts, and openings, between each file, including each Company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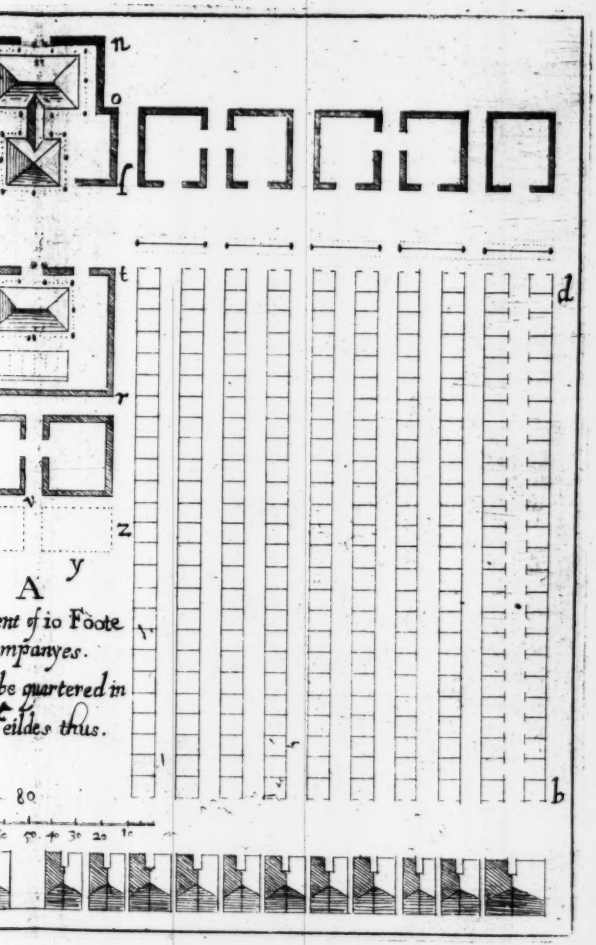
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Company, apart by themſelves, as the 2 outward files *A. C.* and *B. D.* demonſtrate.

I conceive it needleſſe to particularize the dimenſions here, in reſpect many are marked on the Plate, and an exact ſcale ſupplies the defect of the reſt.

PLATE

PLATE XV.

Foraſmuch as the ſecrets in the Art of Gunnery, are many and numerous, and that I intend this book for the pocket; and that thoſe myſteries are publiſhed and layed open already by others, of great, and profeſſed skill, and ſcience therein; I muſt both neceſſarily, and doe purpoſely omit to ſpeak thereof; yet I hold it convenient to pourtract the 4 principall, and chief peeces of *Artillery* uſed in the united Provinces in the Netherlands, (from the which 4 all others have their reaſons, and proportions, either by encreaſing, or diminiſhing.) Becauſe their ſhapes at leaſt wiſe may be available to ſome founders, who perhaps at ſome time may have no better helps.

The firſt is a *Falconet*, weighing ſome 2100 l. weight of metall, and carries a 6 pound ball.

The ſecond is a *Field-piece*, weighing about 3200 l. of metall, and carries a ball of 12 pound weight.

The Spoon, or Ladle wherewith a Peece is laden, (and is made of Braſſe or Copper) is proportioned to the bullet, as the figure moſt plainly repreſents.

PLATE

Plate. 15.

A description of 4 Pe
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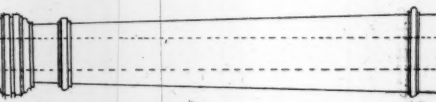
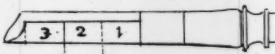
Province



A Falconet, weighing



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f 4 Peeces of Artillerye
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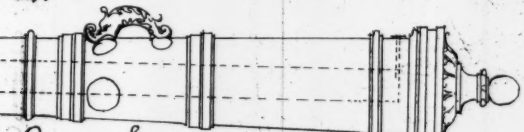
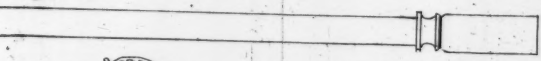
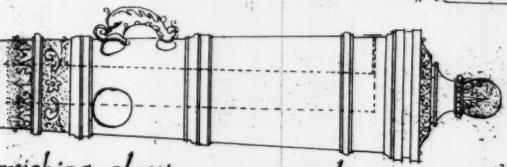
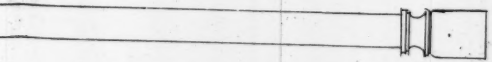


ighing 2100 ℔ or thereabout.





weighing about 3200 poundes.



rammer.

PLATE XVI.

The third is: A *Demi-Cannon*, weighing about 4500 l. of metall, and carries 24 pound ball.

The fourth is a whole Cannon, weighing about 7000 l. of metall, (or, as some will have it, 5600 pound) and carries 48 pound ball.

Lastly, I have drawn the *Ichnographie* of a Peece, whereby the parts, and form of a Peece may the more perspicuously appear; with instructions of the terms of each part, which most properly belong thereunto, plainly denoted by the letters of the Alphabet, which are as followeth.

A. B. the *Diameter* of the muzzell, concave, or boar of the Peece.

C. the freeze.

C. D. the neck.

E. F. the Astragall, or Coronice ring.

G. H. the re-inforced ring.

I. K. the Trunions.

L. M. the Chamber.

N. the base-ring, and the touch-hole marked out to fall just with the end of the boar.

O. the Cascabell, or pummell.

A. L.

A. L. the vacant Cylinder from the charge, for the guide of the ſhot.

M. O. the breech.

M. N. the thickneſſe of the metall at the breech.

The upper mould at *A. B.* is the muſſell-Ring, or Coronice.

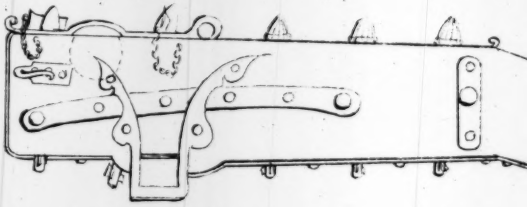
PLATE XVII.

Repreſents the ſeverall parts of a Carriage for the field, the dimenſions thereof are to be fitted according to the proportion of the Peeces, for which they are to be made, which may thus be found out.

Meaſure the Peece for which you intend your Carriage from the Trunions to the Caſcabell, or pummell at the breech; then having firſt drawn an exact draught, or copy of theſe figures, (though much greater, yet correſpondent in proportion) divide the cheek of your Carriage from the hole for the Trunion, to the breech of your Carriage, into ſo many parts, as the meaſure which you ſhall take from the Peece ſhall direct, and by that ſcale make all the appurtenances proportionable. Thus having found your dimenſions, the Plate lays open the forms very perſpicuouſly.

PLATE

Plate. 17.



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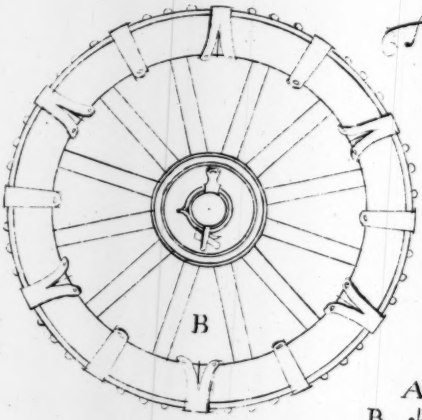
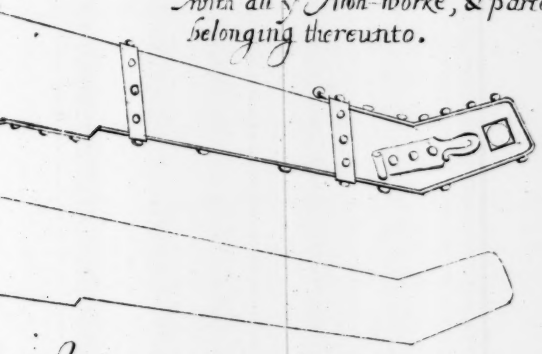


A. the pla
B. shodd &

A Carriage for the Feild.
with all ye Iron-worke, & partes
belonging thereunto.



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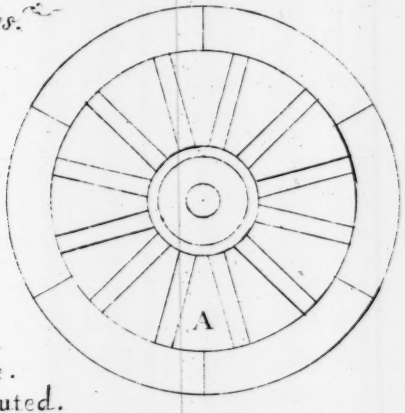

the plaine.
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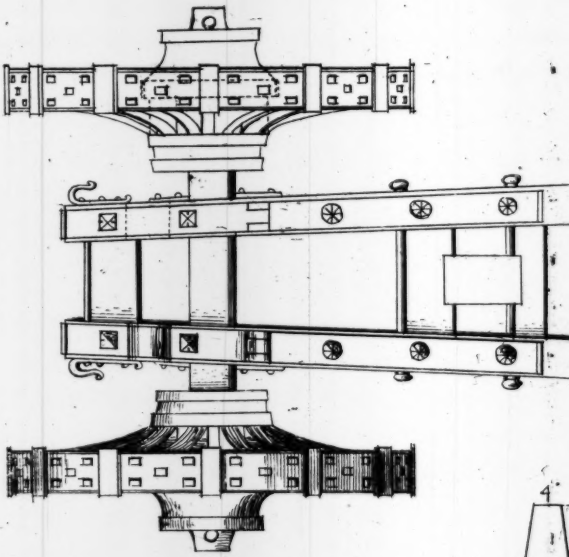
PLATE XVIII.

Expreſſeth the Carriage compleated, that is to ſay, joyned together, & in all points fitted for the Peece, and ready for the march. If you follow this figure in each particular of its Iron-work, nothing there but will ſhew its neceſſity in the uſe thereof; and ſo experience will ſave me the labour.

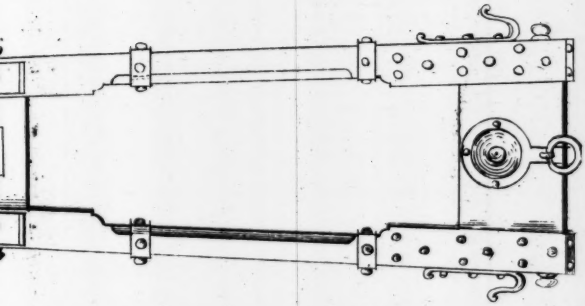
The ſame way (as before) will ſerve to find its meaſures.

Plate. 18.

The Carriag



rriage compleated.



A
(Wedge to raise the breech of the peece to a levell.

PLATE XIX.

Fire-works, and especially the *Petard* and the *Granado*, being very necessary for divers exploits and feats in war, I could not omit to make some mention thereof.

The Petard

Is made of several sizes, and bignesses, having respect to the place unto which it is to be applyed; It is made of fine or red Copper, mixt with a tenth part of Brasse; and first, that for the bridge is commonly of this proportion, 11 inches long, and at the breech 7 inches and a halfe about, and 5 inches wide within; the metall at the breech must be one inch, and ¼ part thick, and ½ an inch thick at the neck, without reckoning the Mussell-ring, the mouth 10 inches wide; and there must be a pipe added to lengthen the touch-hole; as the figure expresseth. It must weigh from 60, to 70 pound of metall.

2. That for gates with Percullises, must be 9 inches long, $\frac{5}{12}$ of an inch thick at the neck, and one inch at the breech. The mouth 7 inches wide, and 6 inches wide on the out-side of the breech, and 4 within. It weighs neer upon 40 pound of metall.

3. That

3. That for ordinary Gates, as alſo for Palliſadoes, muſt be 7 inches long, $\frac{1}{3}$ part thick at the neck, and $\frac{1}{4}$ parts of an inch thick at the breech. The mouth 4 inches wide, 3 inches and an $\frac{1}{2}$ at the out-ſide of the breech, and 3 inches wide within. It muſt weigh neer upon 15 pounds

The charge of the *Petard* for the bridge, is from 5 to 6 pound of powder; of thoſe for ſtrong Gates, from 3 to 4 pound.

And for *Palliſadoes* from one pound and an half to 2 pound of powder.

They muſt be charged with the fineſt powder that can be had, beating it hard into the *Petard*, (but not ſo that you bruiſe the grain thereof) and ſtopping it with a wooden trencher or peece of board of an inch thick, very juſtly fitted thereunto, with waxe melted into the rifts to keep out water; if it ſhould perchance fall into the water.

The *Petard* muſt not be charged up to the mouth, but there muſt be the breadth of 3 fingers left vacant, the which ſpace muſt be filled with towe; hard and cloſe depreſſed, with a linnen cloth bound about the neck of the *Petard*, and ſtrained over the mouth thereof, to hold it in. The touch-hole muſt be ſtopped with cork, and over that, covered with a ſeared cloth to preſerve it from water, or wet.

The *Petard* is to be primed with a mixture which is ſomewhat ſlow in operation, that the *Petardier* may have leiſure to retire, before the reverſe of the *Petard* ſurpriſe him; it is thus compounded. Take 3 parts of fine powder, 6 of Sulphur, and 9 parts of Salt-peter: pound each of them apart very ſmall, then mixe them together in a diſh with a ſtick, then pour oyle of Peter into it, by little and little, (till it becomes a paſte) then let it drie thoroughly in the ſhade, and ſo lade your pipe therewith.

To prevent all miſchief, you ought to be well aſſured of your compoſition, and the length of the pipe you mean to apply to the *Petard*, yet the ſooner it does execution, after the *Petardier* is ſafely retired, the better it is.

The Granado

Is likewiſe made of Copper, caſt in form of a perfect Globe, allowing half an inch, or ſometimes more for the thickneſſe of the metall, which is to be equally thick in all places: and is filled with fine powder, with a pipe of Iron ſcrued into it, and filled with a ſlow compoſition to prime it. They are made of divers bigneſſes, proportioning them to the weight of the bullet, belonging to the Peece out of which they are to be ſhot. If they exceed the boar of

a

a Cannon, then are they to be shot out of a *Morter-Peece*, made for that purpose; they are sometimes made to be cast by the hand.

But because these things are so generally known, I conceive it is but lost labour to mention them at all. But having a very excellent Machine, in nature of a *Petard*, I could not choose but publish it, for the practicall invention, and necessary use thereof, which is as followeth.

If you should chance to have occasion for a *Petard*, and should be destitute of any in readinesse, or of a Founder or metall to cast it; then take a firkin, and place therein a little barrell filled with 40 pounds of powder, the which must have a pipe of iron to reach just into the midst thereof, charged with the slow composition aforesaid. The vacuity between the sides, and the heads of the firkin, and the lesser Barrell must be filled with stones, and the joynts thereof must be run full of grain, to unite them, as it were, into one body. The grain is made of Bees waxe, and Rosin, of each a like quantity, mingled with the dust of brick, or stone. The figure

A.

Represents the form thereof to your view, shewing

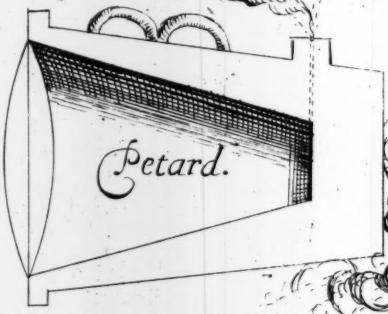
ſhewing the inſide. And being hooped and banded with Iron, as the figure *C.* preſents with croſſe bars of wood at the heads as *d.* let the *Petardier* have ſuch a hook and ſcrue as *B.* expreſſes, and having ſcrued the ſame faſt into the Bridge, Gate, or Palliſadoes, deſigned to be broke up, let him hang this on the hook, by the bail on the top, give fire, and look to himſelf; and it will doe notable execution.

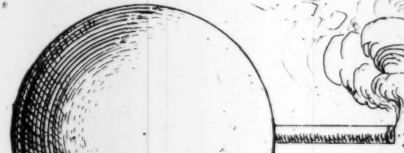
PLATE

Plate .19.

A description of the mo.
in service; Viz. the P

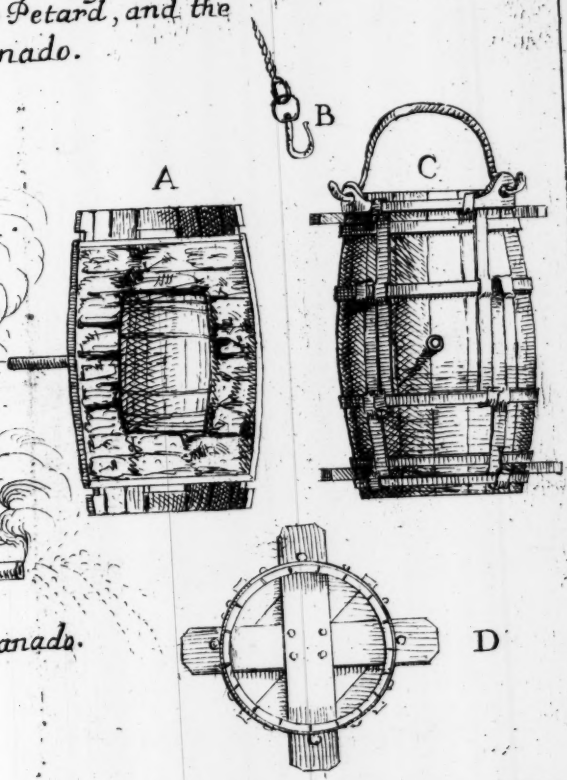
Grana





Granad

nost usefull Fireworkes
Petard, and the
nado.



anado.

PLATE XX.

Having gone through the principall heads of *Fortification*, and other matters tending to action; I thought it would not be very impertinent to end with repose; that being as it were the whet-stone to the former, and thus I have figured it. Two officers sleeping on a bed made of leather, wind-tite, and blown up to bear them from the damp, and unwholsome humidity of the earth; the which from its quality I call a *Ventilet*, signifying a bed of wind. That they are now any where in use, I know not; but, that they have been in use, I am certain; and, that it is possible and very convenient, I am most certain. For being made of Neats-leather, and 6 foot square, or somewhat more, the wind being let out, it will be of good use to cover a Sumptier, and so earn its carriage. The Diagram on the Table directs for the making of it thus.

Provide you of two large Neats-hides, out of which you must cut two Peeces in form of the *Parallelogram*, or long Square, *A. C. D. E.* being between 8 and 9 foot long, and four foot broad, or thereabout; that the corners *A.* and *C.* being doubled over, and joyned at *F.* the lines

Plate 10

lines *D. B.* and *B.* and *B. E.* (which muſt be 2 ſides of the bed) may be 6 foot long, or better, as it is deſired. Then having ſowed the ſeam *D. F.* cloſe, and faſt; (and conſequently the fellow thereof in like manner) In ſowing the 2 peeces together, in the Diagonall ſeame *D. E.* place the Semi-diagonals, alternate; to wit, *B. F.* on the one ſide, and *F. G.* (as the prickt line denotes) on the other ſide; becauſe it is eaſier to faſten 2 corners to a whole ſide, then all the four corners together. There is no other way to make it of fewer ſeams, neither are they ſo apt to break out, by lying on them, as if they were ſewed about the ſides. The corners ought to be rounded off, to gain a thickneſſe: It being conveniently made, according to the former directions, to contain wind. At one of thoſe corners, where the Semi-diagonals commeth (as at *b.* or *g.* becauſe there is but one ſeam to hinder) it muſt be left open; with a gut, of thin, and ſubtile leather faſtned unto it (that will choak very cloſe to keep in the wind, if the bed it ſelf ſhould chance to be too ſtiffe, and hard) in which muſt be faſtned a little block of wood, with a ſcrue-hole through it, juſt fitted to the nozzle of a pair of bellows: Then having ſcrued in the bellows, blow it up, till it is harder, or ſofter to your humour: then with a ſmall leathern-thong, or peece of ſtrong whip-cord,

whip-cord, between the noſe of the bellows and the bed, choak it cloſe. Then ſcrue in a ſtopple (which you muſt have in readineſſe) into the wooden Plugge. And to make it the more certain, you may choak it once more juſt without the ſaid ſtopple, then remember to put off your ſpurs, and doubtleſſe it will contain the wind, and beare you with much eaſe, from the cold ground.

FINIS.

LONDON
Printed by *M. F.* for *R. Royſton*, and are to be ſold at the Sign of the *Angel* in *Ivie-Lane*.
1645.

A TABLE,

Explaining the moſt difficult words, and terms of Art, uſed in this Book:

Alphabetically ſelected, for the help of the plain Engliſh Souldier.

A

ANgle, *Is a Geometricall terme for a Corner, included by two lines, of which there are three ſorts; to wit,* A Right, An Acute, *and* An Obtuſe Angle.

1. A Right Angle, *Is when the two lines meeting doe frame a juſt ſquare Angle of 90. Degrees.*
2. An Acute, *Is when the two lines doe encloſe leſſe then a Square, thereby becoming more ſharpe, and therefore* Acute, *from the Latine word* Acutus, *ſharpe.*
3. An Obtuſe Angle, *Is when the two lines doe include more then the Square, making it thereby the more blunt and dull, and is therefore called* Obtuſe, *from* Obtuſus, *which is Latine for blunt, or dull.*

Aſtragall, *Is a term of Architecture, and is (according to* Vitruvius, *an ancient and famous Author thereof) a ring to deck or adorn the neck of a Columne; and is therefore transferred to the Cannon, agreeing ſomewhat in ſhape with the Columne, or Pillar.*

Avenue, *Comes of the French, and is the ſpace that is left for paſſage to and fro, in and out a Camp, Garriſon, or Quarter: when the place is either fortified with a line of Communication, or Barrocado's.*

C

Capriccio, *Is an Italian word for the rough draught, or first invention of any thing; and is to be pronounced, as if it were written* Capritchio.

Center, *Is an individuall point in the middle of any thing; As the Center of the* Polygon *is the middle of the* Polygon: *a terme in Geometry.*

Counterscarfe *or* Counterscarpe, *Is that side of the moate, which is opposite to the Fortresse.*

Cylinder, *Is that part of the bore of a peece which remains empty when the peece is laden, and takes its appellation from the latine word* Cylindrus, *the roller by which the bore was formed.*

D

Decagon, *Is a Greek compound, and it signifieth a figure of tenne Angles.*

Dodecagon, *Is likewise a Greek word, signifying a figure of twelve Angles.*

Degrees, *A degree according to the Mathematicks is the* 360. *part of the circumference of the world. And consequently of any Circle; for* Euclide *affirms all Circles to be equall. So that the Circle so divided, (to wit, into* 360. *parts) being cut at right Angles in the Center, each Quadrant thereof shall be of* 90. *Degrees.*

Note,

That all Calculations for the Degrees of Angles have reference to a Circle so divided.

Demi, *Is the halfe, as a* Demi-Cannon, *(that is) halfe a Cannon.*

Diagram, *A word used by the Mathematicks for any thing that is demonstrated by lines; a Greeke compound.*

Diameter,

Diameter, *Is a Geometricall terme, derived from the Greeke for the extent of a Circle, and is a ſtraight or meaſuring line, that croſſeth from border to border, or from ſide to ſide of any Figure.*

E

ENchiridion, *Signifies a handfull of any thing; alſo a manuell, or portable volume or booke: it is originally compounded of Greeke words, which doe include ſo much.*

Enneagon, *Is alſo compounded of the Greeke, ſignifying a Figure or ſuperficies conſiſting of nine ſides, and Angles, but it chiefly takes its denomination from its Angles.*

Exteriour, *Is the outward part, or ſide of any thing.*

G

GEometry, *As* Adrianus Metius *defines it, is the Art of meaſuring well.*

Now to give you ſomewhat more ſatisfaction herein, I will a little enlarge this definition, being aſſured that it cannot be loſt labour for any who deſires to peruſe this Booke.

1. *To meaſure well, is to interpret, and exerciſe the meaſurable nature, power, propriety, ſtate, and uſe of any thing.*
2. *The ſubject of Geometry is Magnitude, and Magnitude is a continued quantity, whoſe parts agree to a common terme, but a terme is the extreame of magnitude.*
3. *Magnitude, is either a line, or a lined figure.*

A line, is onely magnitude in length.

A lined figure is made out of lines compoſed: or as Ramus *defines it,*

A lined Figure, is more then Magnitude in length, and is either a Superficies, or a Body.

A Superficies, *Is onely the ſurface of a lined figure of length and breadth.*

A Body, *Is a Figure consisting of length, breadth, and depth.*

The first part therefore of measure, is to be understood of lines.

The second of Superficies.

But the third, of Bodies.

So much shall suffice to explaine what Geometry is, but to shew amply its extent and power, requires a greater writer and volume.

H

HExagon, *Is a Greeke compound, signifying a Figure of sixe Angles.*

Heptagon, *Is in the like manner compounded, and derived of the Greeke, and doth signifie a Figure consisting of seaven Angles.*

I

ISoceles, *Looke for Triangle.*

Ichnographie, *Is a description of any work, according to its tract or tracery on the ground, as it were the foote-steppings of the worke. It is a Greeke word.*

Interiour, *Is the inward part or side of any thing.*

Irregular, *Is a disagreeing of the one side, (or more) to the rest of the Figure, which causeth also an incoherence amongst the Angles: wherefore any Figure whose Angles and sides doth disagree in dimension, is called an irregular Figure.*

O

OBlong, *Is a Geometricall terme for a Quadrangular Figure, whose length exceeds its breadth, of which the most proper (distinguished by their severall termes)*

an

are theſe ſixe following.

1. Seſquialter, *Which is when halfe the height is added to its length.*
2. Seſquitertia, *Which is when a third part is added to its length.*
3. Seſquiquarta, *That is when a fourth part is added.*
4. Diagonea, *Which is when the Oblong is increaſed to the length of the diagonall of the ſingle ſquare.*

The Diagonall, *Is a line drawn from corner to corner.*

5. Superbitiens tertias. *ſo called* (quaſi ſuper bis tertias) *becauſe the length thereof is encreaſed by two thirds.*
6. *And laſtly,* Dupla, *which is a double ſquare.*

The which ſeaven proportions of ſquares: to wit, Quadratus, *or perfect ſquare:* Seſquialter, Seſquitertia, Seſquiquarta, Diagonea, Superbitiens tertias, *and the* Dupla, *or double ſquare, are held to be more pleaſing to the ſight then any mediocrity between either of the ſaid proportions.*

Octogon, *From the Greeke ſignifies a Figure which conſiſteth of eight Angles.*

Orthographie, *Alſo a Greek compound, ſignifies in this place chiefly the upright erection of any work, as it doth preſent it ſelfe to the view being finiſhed. As alſo it is ſometimes taken for true, and exact writing.*

P

Parapet, *Is a breaſt worke, taken from the Italian, ſignifying equall to the breſt, or breſt high.*

Parallelogram, *Is any Figure which hath his lines every where a like diſtant, each ſide running parallel one unto the other.*

Thoſe lines are ſaid by Euclide *to be parallel, which being drawn forth to an infinite extent, ſhall run equi-diſtant,*

and neither croſſe, nor touch one the other.

Pentagon, *Is a Figure of five Angles, Greek.*

Peroration, *The concluſion, or laſt part of a diſcourſe.*

Polygon, *Is any Figure compoſed of many Angles, and may be applied either to the Regular, or Irregular.*

Profile, *An Italian word for that deſigne that ſhowes the ſide with the riſing and falling of any work, as a face drawn ſide-wayes, is called the Profile.*

R

REgular, *That is uniforme, or alike in all parts, both in forme and dimenſion.*

S

SAp, *or trenches of Approach.*

Scala, *or* a Scale, *Is a meaſure proportionable to the draught; as the juſt meaſure muſt be to the work it ſelf, whether it be of Feet, Yards, Perches, or Rods. And is the onely compendious, and exact demonſtration of the proportions of any work, which is to be expreſſed by deſigne.*

Scenographie, *Is the modell or draught of any work preſented with its ſhadowes, according as the worke it ſelf ſhowes, with its dimenſions according to the Rules of Proſpective.*

Semi, *that is to ſay, the halfe; As a ſemidiameter, halfe the diameter.*

T

TRiangle, *A Figure of three Angles, of which there are ſixe ſorts.*

1. Equilaterall, *Which is when the three ſides thereof are of an equall length, and the Angles all equall among themſelves.*

2. An

2. An Iſoceles triangle, *Is that which hath two equall ſides, and two equall Angles oppoſite to thoſe ſides.*
3. All irregular triangles, *Having three unequall ſides and Angles, are knowne in Geometry, under the term of* Scalenum.
4. An Oxugoneum, *Is a triangle having three acute Angles.*
5. An Amblugoneum, *Is a triangle having two acute Angles, and one obtuſe.*
6. *And laſtly,* an Orthogoneum, *Is a triangle which hath one right Angle.*

Theſe diſtinct Terms are properly to be given to each kind in a demonſtration, where many triangles come in competition for diſtinction ſake, otherwiſe it is not requiſite to be too nice therein.

There are many other words (perhaps in the very explanation it ſelf) which to ſome may chance need explaining. But I conceive ſuch are not worthy the taking notice of.

PERORA-

PERORATION

To the Reader.

AS I am not preſumptious enough, to conceive this worke above the knowledge of moſt Gentlemen; who by their ſtudies have attained to greater perfections then can be pretended either in the Art or Language of this: So neither am I ſo ignorant, to think that any illiterate and mean capacity, being neither prepared by the ſtudy of Letters, nor knowledge of Geometry, can attain to the Science handled in this Treatiſe, without ſome more direct, and plainer language, then the proper Termes, be added to his induſtry. For the which reaſon, and for whoſe benefit alone (being alſo adviſed thereunto by ſome friends) this precedent Table was inſerted. Wherefore I concluded it would be vain to write the particular Etymologies of each word, much leſſe thoſe

thoſe deſcended of the Greeke, ſince their Characters would rather prove an obſtacle, then any enlightning to the unskilfull. But I know the age wherein we live, affords but few that will confeſſe themſelves under that notion guilty of the neceſsity of this Table. But on the contrary, in ſtead of deficiency, many are rather apt to aſſume a power of Correction: who though they be not able to performe that, yet will ſtrive all they may, to come ſo far at leaſt as to find the fault; and rather then fail, if the matter and *qualitie* of the work prove ſteel againſt the leaden point of their detractions, they will not ſpare to bring the *quantitie* within the reach of their deſpites. The which if that be all they can object againſt this, (though it derogate from the honour of a Writer, as much as from the moſt experienced Captaine, to anſwer the Objections, or bold Challenges of every empty, and idle humoriſt:) In pitty to their ignorance, I will afford

afford them this ſatisfaction into the *Handfull*, written by an ancient Authour, *Damocharis.*

Μὴ νεμέσα βαιοῖσι χάρις, βαιοῖσιν ὀπηδεῖ.
Ne parva averſeris, ineſt ſua gratia parvis.

And that the worſt of Cenſures may light on themſelves, will bring them within the bounds of Ingratitude, if they doe ſtill perſiſt Calumnious: by befriending them (in lieu of their malicious carpings) with this heatheniſh line tranſlated into Engliſh leſt they ſhould be non-plus'd in their pretendings:

Reject not things becauſe they'r ſmall or few:
For even the ſmalleſt have their graces too.

And ſo courteous Reader, I humbly take my leave, as much ſubmitting to the cenſure of the Judicious and Learned; as ſlighting that of the reſt.

Farewell.

An

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To the COMPOSER of this worke.

OLd Father Adam *was the greateſt Prince*
That ever was or will again, but ſince
The revolution of that fatall houre
When ſinne from Tophet came with ſuch a power,
Baniſh'd was Adam *by th' Eternall Word,*
And Eden guarded with a flaming ſword:
So that we ſee with apprehenſious eyes
The firſt great Court-of-Guard was Paradiſe,
Twixt time and what you write ther's ſuch affiance,
The Sun's but ſixe dayes elder then the Science;
And ſo well fortifi'd this Booke appeares
That Criticks dare not ſiege it for their eares.

ROB. CHAMBERLAIN.

LONDON, Printed for *Richard Royſton*, 1645.